# Investigation of the June 14, 2007, Incident at U.S. Highway 90 across St. Louis Bay, Pass Christian, MS

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

December 2007

# REPORT

# Investigation of the June 14, 2007, Incident at U.S. Highway 90 Across St. Louis Bay, Pass Christian, MS

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# REPORT

## INCIDENT:

On June 14, 2007, a construction incident claimed the lives of two construction employees at the site of the new Bay St. Louis Bridge on U.S. 90. The new bridge under construction will connect the towns of Bay St. Louis on the west and Pass Christian on the east. Gulfport and Biloxi are major cities nearby. Hurricane Katrina destroyed the old bridge located just a few yards away from the location of the new bridge. The incident occurred when the steel forms of a bridge column # 31 WB (west bound) suddenly collapsed and fell into the bay while the form was being filled with wet concrete. The column form, approximately 12' by 6' and approximately 46' high, had received approximately 94 cubic yards (CY) of concrete at the time of the incident.

The bridge is a design-build project awarded to a joint venture of Granite Construction Company of Watsonville, CA, and Archer Western Contractors of Atlanta. The joint venture is called Granite Archer Western (GAW). The bridge consists of four lanes supported by two independent structures, side by side. Each structure supported two lanes. The south bridge was opened in May and carried traffic in both directions until the completion of the north bridge, see figure 4. The incident occurred on the north bridge under construction.

The following were the key players:

1. Owner: Mississippi Department of Transportation (MDOT)
2. General Contractor: Design-Build Project: Granite Archer Western
3. Concrete Supplier: Gulf Concrete (GC) of Gulfport, MS
4. Formwork designer and supplier: EFCO of Des Moines, IA
5. Bridge Structural Designer: The HNTB companies (HNTB) of Kansas City, KS. (a part of the design-build team)
6. Quality Control: HNTB subcontracted to Civil Tech
7. Quality Assurance: URS, Inc. contracted by MDOT

EFCO prepared the shop drawings for the forms of the concrete columns and furnished all of the parts but did not erect them. Assembly, transportation from the dock to the bridge location, and actual erection of the forms were GAW's responsibility. EFCO was not responsible for furnishing, designing or erecting the column form braces. EFCO clearly noted on their drawings that the braces were the responsibility of others.

GAW assembled the column forms on a barge either near the dock or near the actual location of the columns. Generally, the column forms were to be assembled in three pieces; one top piece containing column form and platform, and two bottom pieces for the column form. The top 7' high piece would be assembled with all four sides connected to each other, and to a working platform installed on the top. The bottom portion of the column form was assembled in two L-shaped pieces. Each L-piece consisted of two sides, one long side and one short side, connected to each other. The crane first placed the two L-shaped pieces around the rebar cage and the employees then bolted them together, and then aligned and plumbed the forms. The pre-assembled top forms were then placed over the just assembled L-shaped pieces and then connected together. A similar erected column form is shown in figure 6. The forms were braced by sloping pipe braces connected at the top to the column forms and at the bottom to the forms of the footing forms.

Gulf Concrete Inc. (GC) was the concrete supplier for the project. GC established a batching plant near the site for economy and efficiency, as large volumes of concrete were required for the bridge construction. The normal procedure was for GC to deliver concrete in mixing trucks to the dock and empty them into concrete buckets on barges. Each barge had two buckets; each had a capacity of 5 cubic yards (CY). After two barges were loaded with concrete, a tugboat then towed the barges in a row, to the location of placement of the footings or columns. A crane placed over a nearby barge, see figure 5, then hoisted one bucket at a time and swung it to the top of the platform and through a funnel and tremie, the concrete would then flow from the buckets to the inside of the column forms. After one bucket was emptied, the crane hoisted another bucket. After the concrete from all four buckets were emptied, the tugboat took the barges back to the dock to make room for another series of barges with buckets full of concrete already waiting in line. The process would continue until the entire footing or column form was filled with concrete.

The incident occurred at the westbound column # 31 on the north bridge. The column, 12'x 6'x 39' high, was located in the center of the column footings, 25'-6" by 20'-6". The footing was completed a few weeks earlier but the forms were left intact and were not stripped. The footing was supported by eight 30"x 30" concrete piles driven some 110' deep into the bearing strata. The column form was erected a day earlier on June 13. The forms stripped from column 30 WB were erected in three pieces. The bottom portion of the forms consisted of two pre-assembled L-shaped pieces and these were hoisted and placed around the rebar cage. The two pieces were then connected to each other to form a rectangle with an inside dimension of 12' by 6'. The top piece of the column form was then placed over the just connected L-shaped forms. Four braces consisting of round pipes were then erected to provide stability to the forms. The braces were connected at the top near one-third of the height from the base of the column form and at the bottom; the braces were supported on the concrete forms of the footing as they were not yet stripped.

On June 14, GC began delivering concrete to the dock in trucks and it was promptly unloaded into buckets on barges to cast the column 31 WB. One barge had two buckets. After four buckets were filled with concrete, the barges were towed by a tugboat to the location of column 31 WB. The crane operator began hoisting the buckets one at a time and began unloading them into the concrete form through the funnel and tremie. As the crane operator was unloading the $19^{th}$ bucket at the top of the platform, he suddenly heard a loud bang and saw the concrete form falling in a northeast direction into the bay. Three employees located on the top platform quickly hung onto the concrete bucket and were safely brought down. The three employees inside the column forms who were engaged in vibrating the concrete and the other employees on the top platform fell with the column into the bay.

There were twelve employees involved in the concrete placement. Ten were employed by the general contractor, Granite Archer Western (GAW). The other two were employed by Civil Tech Inc. (CT) and URS Inc. CT was a subcontractor to HNTB Inc. HNTB had a contract with the joint venture for quality control. URS had a contract with the Mississippi Department of Transportation (MDOT) for quality assurance.

Of the ten GAW employees, two were located inside the column form vibrating the freshly poured concrete, two were located above them inside the column form turning the vibrator on and off, and two were located at the top of the rebar cage, also inside the column form, supervising the employees below. The other four GAW employees were situated on the very top platform directing the crane operator and assisting in the transfer of the concrete from the buckets to the tremie into the column form. There were two additional employees on the top platform. One worked for URS on quality assurance and the other worked for CT on quality control.

Nine employees fell into the bay with the fallen column. Three employees on the top of the platform latched onto the concrete bucket and were safely brought down by the crane operator. Of the nine, eight were rescued shortly after the incident and were taken to the hospital. One of the employees who was pronounced dead on arrival at the hospital was a CT employee. The remains of the ninth employee were recovered the next day; he was a GAW employee.

The column fell in a north-easterly direction with the reinforcing cage arching in the same direction. There was very little concrete adhering to the reinforcing bars, indicating the highly fluid state of concrete up to the time of the failure, see figures 8 thru 13. Almost all the concrete fell into the bay. The lower piece of the column form approximately 39' high fell in one piece with the bottom 9' of the north side folding approximately 180 degrees. The bottom seam of the column form at the south-west, north-east and north-west were torn apart for am approximately distance of 9'. The seam at south-east remained intact. The upper piece of the form approximately 7' high supporting the platform fell in to the bay in one piece, see figure 7.

**Structural evaluation**:

EFCO designed and furnished the formwork elements for the bridge columns. GC's personnel assembled and erected the formwork. Generally, the rectangular formwork was assembled in two L-shaped pieces and transported to the location of casting and then the two pieces were bolted together with high strength bolts at 12" o.c. Forms were stripped from column No. 30 and transported to column No. 31. The forms were assembled on column No. 31 the same day they were stripped from column No. 30. EFCO form drawings indicated that the forms were designed to withstand a maximum hydrostatic pressure of 1000 pounds per square foot (psf). The general contractor was aware of this limitation and this fact is not disputed. The pressure on the forms would vary depending upon a number of factors, e.g., rate of placement of concrete, height of the column, ambient temperature and the use of retarders and fly ash in the concrete. The concrete industry uses the American Concrete Institute guide known as ACI-347 to compute the pressure exerted by the wet concrete on the forms and this guide is regarded as the industry standard.

The ACI-347 has also been incorporated in the Standard Specifications for Highway Bridges, Seventeenth Edition, 2002, the governing document for this bridge construction. The following is an excerpt from the specifications:

"The structural design of formwork shall conform to ACI standard, "Recommended Practice for Concrete Formwork," (ACI 347) or some other generally accepted standard. In selecting the hydrostatic pressure to be used in the design of forms, consideration shall be given to the maximum rate of concrete placement to be used, the effects of vibration, and the temperature of concrete and any expected use of set-retarding admixtures or pozzolanic materials in the concrete mix."

As EFCO had indicated the limits of their design, it was then the general contractor's responsibility to ensure that with due consideration of all the variables discussed above, the hydrostatic pressure on the forms did not exceed the maximum allowable value.

**EFCO design:**

The column in question was 12' x 6'. The EFCO forms consisted of 3/16" steel plates reinforced with Z-shaped elements welded to the plate at 12" o.c., see figures 2. EFCO provided drawings for WB 31 column form, see figure 3. The Z-shaped elements greatly enhanced the plate's bending capacity. The physical properties of the elements were provided by EFCO. The yield strength of the steel was 36 ksi. High strength A 325 bolts were used to connect the two L-shaped pieces. Using a simple bending span of 12', it was determined that the forms would be capable of safely supporting a hydrostatic pressure of 1000 psf with the code prescribed factors of safety. It was also determined that if factors of safety were not considered, and the forms were stressed to their ultimate values, the forms would fail at a hydrostatic pressure of 2,700 psf. The analysis was done using American Institute of Steel Construction (AISC) Load and Resistance Factor Design. The load and resistance factors were assumed to be 1.0 to determine the ultimate failure loads. This gave a factor of safety of 2.7 in the EFCO design. The connecting bolts had higher failure loads. The EFCO design was, therefore, considered satisfactory.

**Rate of placement of concrete**:

As discussed earlier, concrete was transported to the column location by two barges at a time, pulled by a tugboat. There were three tugboats and six barges available at the site on the day of the incident. Each barge contained two buckets, each bucket containing 5 cubic yards of wet concrete. Once the tugboat reached the column location, the crane would hoist the four buckets, one at a time, to unload the concrete into the column form. The barges would then return to the dock to bring fresh concrete. The next set of barges waiting in line would take its place, and the process would continue, ensuring a continuous flow of concrete. Each trip of the barges would bring 20 cubic yards of concrete (4 x 5 cubic yards = 20 cubic yards). Concrete contained in 8 buckets brought in four trips by the tugboats was all placed in the column form. Concrete brought in the fifth trip was being unloaded. The crane had unloaded two buckets from the fifth trip completely and was unloading the third bucket when the incident occurred. Approximately one cubic yard of concrete from the third bucket remained to be placed. Based on the above, approximately 94 cubic yards of concrete was placed in the form up to the time of the incident. Given the column's dimension of 12' x 6', a height of approximately 35 feet of wet concrete was placed in the form before the incident.

The first concrete truck for column 31WB left the batching plant at approximately 9:15 a.m., arriving at the dock at approximately 9:30 a.m. With the time required to load the buckets on the barge, and transport them to the column location, the placement of concrete in the forms began at approximately 10:00 a.m. As discussed, concrete was continuously brought out by the barges and placed in the forms. By most accounts, the incident when the forms failed and overturned in the water occurred at approximately 1:00 p.m., see figures 8 to 13. Given the fact that the concrete was placed up to a height of approximately 35 feet in three hours, the rate of placement was approximately 11'-8" per hour.

EFCO shop drawings for the column formwork provided a graph to determine the maximum rate of placement of concrete, see figure 1. The graph accounted for the use of fly ash, retarder, and ambient temperature. The graph indicated that the rate of placement of concrete should not have been greater than 2'-8" per hour. The actual rate of placement was much higher, i.e., 11'-8" per hour.

**Concrete mix design**:

The contractor ordered 105 cubic yards of concrete, which was later increased to 112 cubic yards, conforming to a mix design No. G4200AAR from the concrete supplier. Copies of mix design G4200AAR were readily available from the general contractor. AA indicates high slump concrete and the last letter R signifies the use of a retarding agent in concrete that is primarily used to extend the initial setting of concrete to provide extra time to transport the concrete and place it in the forms. Generally speaking, three ounces of retarder per 100 pounds of cement and fly ash would extend the initial setting time of wet concrete by two hours or more. In this design mix, pozzolith 100 XR, type D manufactured by Master Builders (BASF) was used, as stated in the mix design. BASF states in its product data that pozzolith 100 XR will "generally extend the setting time of concrete containing normal portland cement approximately 1½ to 8 hours compared to that of a plain concrete mixture, depending on job materials and temperature". The design mix using 100 XR and other admixtures prepared by Gulf Concrete indicates an initial setting time of 6 hours and 15 minutes. Further BASF product data indicates that pozzolith 100

XR provides “excellent performance” in slump retention. Simply stated, this would mean that the concrete with 100 XR would remain “fluid” for a longer time.

The decision to use G4200AAR in columns was made by the concrete supervisor of the contractor contrary to the contractor’s work plan document. It is believed that this decision was prompted by the earlier experience of the contractor when the concrete without the retarder would begin to harden even before it could be placed in the forms. The work plan indicated the use of the concrete without the retarder, i.e., G 42000AA, see attachment A. On June 13, the contractor had used the same design mix, G4200AAR, earlier to complete the first lift (36’ high) of column 36WB. Concrete for column 36WB was scheduled to be placed in two lifts, the first lift being 36’ high. On June 11, the same design mix was also used to cast column No. 30WB (36’ high). The rate of placement of concrete in columns 36WB and 30WB is not known. The employees, however, stated that the rate of placement of concrete in the failed column was much faster than for the previous columns.

The Mississippi Department of Transportation had tentatively approved the mix design, G4200AAR, on August 31, 2006 subject to site verification, see attachment B. The retarder used in the design mix was pozzolith 100 XR, type D manufactured by BASF, Inc. The mix design called for 2 to 4 fl. oz. of the retarding agent per cwt of the cementitious material. As per the mix design, 608 pounds of cement and fly ash were used per cubic yard of concrete. At the rate of 2 oz. of retarder per cwt, 12.2 oz. of retarder was required per cubic yard of concrete. The concrete delivery tickets consistently indicated 12.2 oz. of retarder per cubic yard of concrete. This mix design also used 140 pounds of fly ash, class F, per cubic yard of concrete. The amount of air entrained, AE 90, was in the range of 3-6%, as per the mix design.

The testing agency for quality assurance tested the concrete at the site from the concrete truck bearing ticket No. 10916668 at approximately 11:45 a.m. and noted the following observations, see attachment C.

Slump = 8”
Air content: 5.3%

Air temperature: 93 degrees
Concrete temperature: 86 degrees

The testing agency for quality control also tested concrete from truck # 10916663 and provided the following results, see attachment E.

Slump = 7 ½”
Air content: 3.9%
Air temperature: 90 degrees
Concrete temperature: 88 degrees

The slump and the air content were within the range of the mix design. The concrete was not tested to determine the actual amount of retarder present in the concrete. Immediately following the incident, however, the general contractor and concrete supplier retained a consultant, Alabama Scale & Instruments, Inc. of Mobile, AL to examine the accuracy of the batch controller at the Henderson Point batch plant of Gulf Concrete. The purpose of the tests was to determine whether the actual amount of ingredients and admixtures in the concrete were as they were claimed to be. Generally, the test results were within the acceptable range of the Mississippi DOT except for the retarder 100XR. Three tests were done for the retarder. The amount of variation was +15%, +14% and +17% in the three tests, see attachment D. Though these variations exceeded the MDOT limits of 3%, they were still within the range of the mix design. Mix design G4200AAR permitted the use of the admixture 100XR from 2 to 4 oz. per cwt. The claimed amount of retarder was 2 oz. and with an increase of perhaps 16%, the actual amount would be 2.32 oz., still less than the upper limit of 4 oz.

**<u>Water floating at the top of the concrete:</u>**

As stated earlier, concrete began to be placed in the forms at approximately 10:00 a.m. There were six employees situated inside the column form; two were vibrating the concrete; the other two were located a few feet above, assisting the employees below in holding the tremie and turning the vibrator on and off; and the last two were standing over the plywood at the top of the rebar cage, supervising the four employees below. At the very top of the form was a working platform where six employees were located. Four were employees of the general contractor assisting and directing the placement of concrete by signaling to the crane operator and operating the handle of the concrete buckets. Another employee was the MDOT-retained URS technician performing quality assurance and the other worked for Civil Tech Inc., a subcontractor to HNTB to perform quality control.

The employees inside the formwork immediately noticed that the concrete was too "watery", something they had not noticed in earlier pours. As the concrete was being continuously placed at a relatively faster rate according to the general contractor's superintendent, the problem of the concrete being too fluid became a matter of increasing concern to them. The employees noticed that approximately 4" of water was standing at the top of the concrete. As the concrete placement progressed, the amount of water standing at the top of the concrete increased to 8". They brought this development to the attention of both the general contractor's foreman positioned inside the column, and the technician on the platform. The foreman heard of this situation and conveyed the concerns to the superintendent. Concrete, however, kept on coming and the placement of concrete continued until the failure at approximately 1:00 p.m.

After the incident, one of the eyewitnesses inside the column stated that "the whole time we were pouring concrete, we had 6" to 8" of water in the concrete. We told the foreman that it was too watery. The inspectors did not say anything. One was sleeping and the other was taking notes but did not say anything. The foreman said he was going to inform the superintendent the next time they placed an order. After we dropped the first batch we had about 4 inches of water; 30 minutes later, the second batch came and it added about another 4 inches of water." Another eyewitness, also inside the column, stated that "we poured approximately 13 or 14 buckets of concrete. At that time there was about 6-7 inches of water on top of the cement. When I was standing at grade level, there was about 6 to 8 inches of water on top of the concrete." The contractor's foreman, also an eyewitness inside the column, acknowledged in his statement that "an employee* told me that the concrete was too watery. At about the 8th bucket an employee* told me that it was still too watery and that it was not getting fixed; an employee* said that they

* = Name of employee withheld

were sending it too fast. I told the URS guy and I told superintendent. I do not know if the URS inspector called his boss. I was inside the column when I told the URS inspector. We have never had this much water before."

It was, therefore, well documented that the concrete continued to retain water to the extent that as much as approximately 8 inches of water was standing at the top of the concrete, delaying the onset of the initial setting of the concrete. In normal conditions, concrete would begin to gel and the ingredients would begin to bind together even before the initial setting time, thus partially relieving the forms of the full hydrostatic pressure. In the present case, however, due to the retention of water in the concrete, the concrete remained fully fluid and continued to exert the full hydrostatic pressure. At the time of the incident, a height of approximately 33'-8" of concrete was placed in the column forms, exerting a lateral pressure of 150 pcf x 33.67 feet = 5,050 pounds per square foot, above the ultimate capacity of the forms.

The above circumstances warranted immediate action on the part of the general contractor to address the adverse condition of water standing above the concrete, as reported by the employees. Instead of temporarily stopping the placement of concrete until corrective measures were determined by consulting the concrete supplier, EFCO' engineers or design structural engineers, the work was allowed to progress unhindered, resulting in a catastrophic failure.

**ACI 347:**

ACI 347 requires that unless the concrete slump is 7" or less, the forms must be designed for the full hydrostatic lateral pressure of newly placed concrete. It provides an equation of $P = wh$, with $w$ being the unit weight of concrete, and $h$ being the depth of the plastic concrete. The fact that the slump of the design mix and the actual concrete furnished by the concrete batch plant was 8" was known to all, and this is not disputed. Based upon the $P = wh$ formula, the lateral pressure amounted to 5,050 pounds per foot, many times greater than the maximum allowable pressure of 1,000 pounds per foot.

For the sake of discussion, if the slump is not considered a violation of the ACI 347, the lateral pressure was computed to be 1,400 pounds per foot. Given the rate of concrete placement of approximately 11’-4” per hour and the temperature of 90 degrees, ACI 347 pressure equation,

$P_{max} = C_W C_C [150 + 43{,}400/T + 2800\, R/T]$ (for concrete slump not greater than 7”)

Where $P_{max}$ = maximum design lateral pressure

$C_W$ = unit weight of coefficient which is 1.0 for 150 pcf

$C_C$ = chemistry coefficient (explained below)

$T$ = temperature of concrete during placing (explained below)

$R$ = rate of placement of concrete

yielded a lateral pressure of 1,400 pounds per foot. Chemistry coefficient $C_C$ was 1.4 because of the use of retarder and fly ash. The contractor used concrete mix G4200AAR (MDOT Mixture No. AA67.0609700) which contained the following chemical admixtures.

- AE 90 admixture, air entraining admixture.
- Pozzolith 322 N admixture meeting ASTM C 494 requirements for Type A, water reducing.
- Glenium 3030 NS admixture meeting ASTM C 494 requirements for Type F, water reducing, high range.
- Pozzolith 100 XR admixture meeting ASTM C 494 requirements for Type D, water reducing and retarding.

**Conclusions:**

1. The contractor violated OSHA standard 1926.703(a)(1) because the column formwork was not capable of supporting the lateral load of the wet concrete.

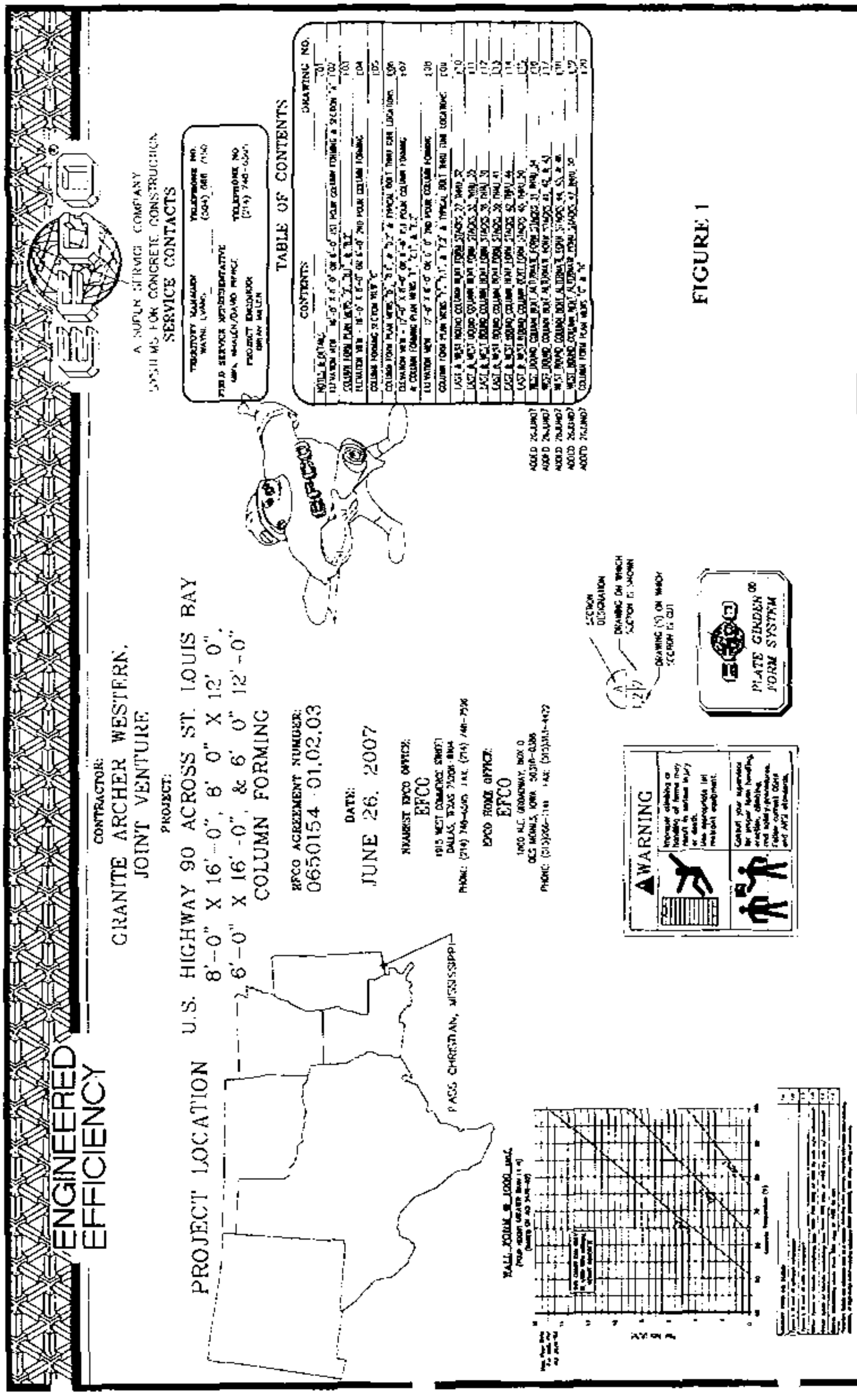
2. Given the ambient temperature, rate of placement of concrete, concrete slump, and the admixtures used in the concrete design mix, the lateral pressure of the concrete on the column forms exceeded the maximum allowable pressure of 1000 pounds per square foot recommended by the formwork designer and manufacturer. The formwork drawings provided a graph to readily determine the rate of placement of concrete in to the column form.

3. Based upon the fact that the concrete had a slump higher than 7”, the pressure of the concrete on the forms was five times the maximum allowable pressure, as per American Concrete Institute ACI 347. Standards Specifications for Highway Bridges, Seventeenth Edition, 2002, requires that the structural design of formwork shall conform to ACI 347.

4. Even without considering that the concrete slump was higher than 7”, the lateral pressure on the form, as per ACI 347, was 40% greater than the maximum recommended pressure based upon the use of fly ash, retarders, rate of placement of concrete, and the ambient temperature.

5. The contractor’s superintendent and foreman failed to take remedial measures in response to repeated warnings from the employees who were placing concrete in the column forms indicating that the concrete was too “watery” and that water, as much as 8”, was floating on the top as the concrete was being placed. If the contractor’s superintendent had taken immediate action, the incident could have been averted.

6. The testing agency retained by the Mississippi DOT was negligent in monitoring the quality of the concrete being placed in the column forms because its representative dismissed the warnings from the employees that the concrete was too “watery” and that water was floating over the top of the concrete. If the representative had taken immediate action, the incident would have been averted.


ENGINEERED EFFICIENCY
A SUPER SERVICE COMPANY
SYSTEMS FOR CONCRETE CONSTRUCTION
SERVICE CONTACTS
TABLE OF CONTENTS
PROJECT LOCATION
PASS CHRISTIAN, MISSISSIPPI
CONTRACTOR:
GRANITE ARCHER WESTERN,
JOINT VENTURE
PROJECT:
U.S. HIGHWAY 90 ACROSS ST. LOUIS BAY
8'-0" X 16'-0", 8' 0" X 12' 0",
6'-0" X 16'-0", & 6' 0" 12'-0"
COLUMN FORMING
EFCO AGREEMENT NUMBER:
0650154 01,02,03
DATE:
JUNE 26, 2007
NEAREST EFCO OFFICE:
EFCO
EFCO HOME OFFICE:
EFCO
WARNING
PLATE GIRDER FORM SYSTEM
FIGURE 1

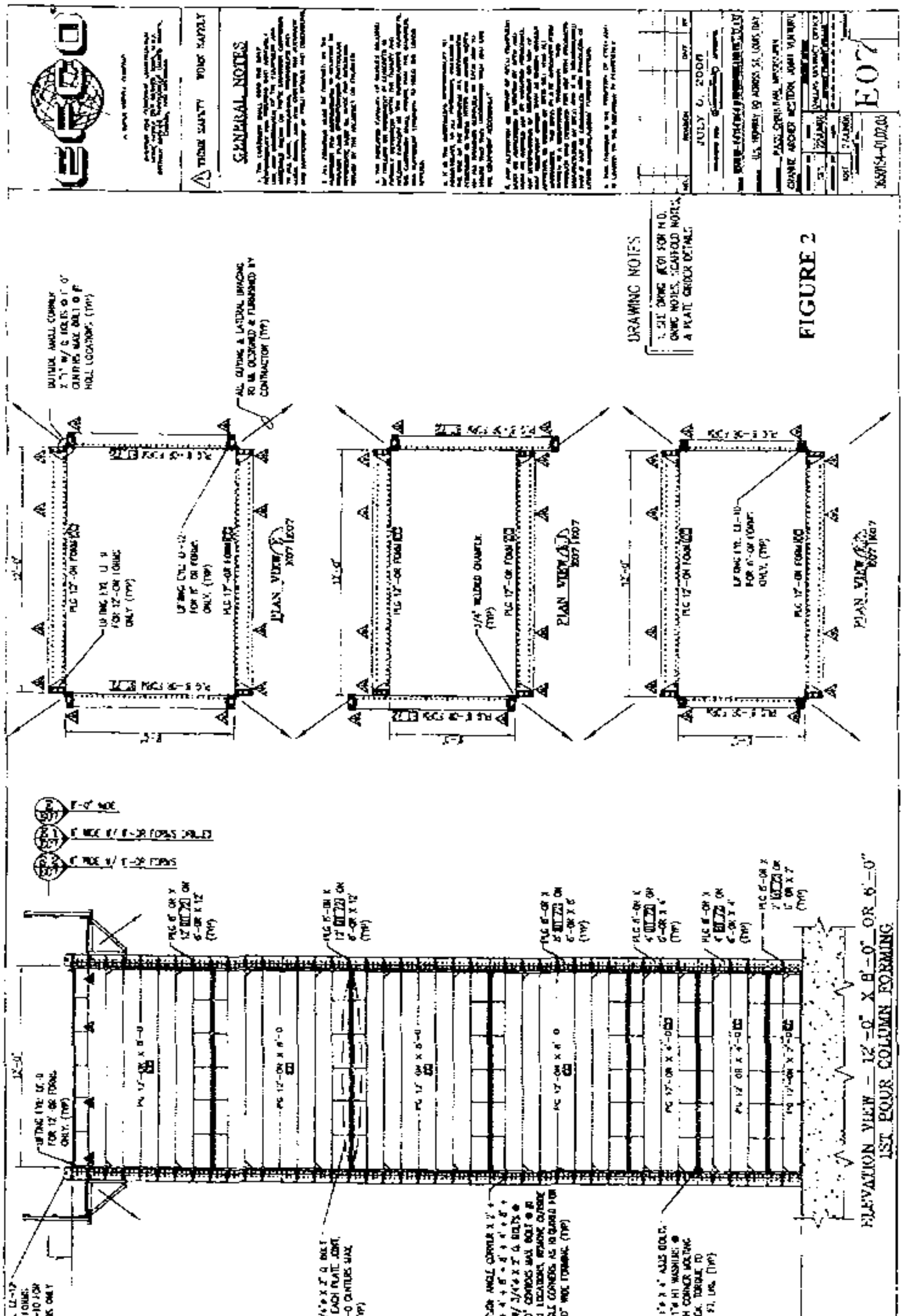


FIGURE 2
GENERAL NOTES
DRAWING NOTES
PLAN VIEW
ELEVATION VIEW – 12'-0" X 8'-0" OR 6'-0"
1ST POUR COLUMN FORMING
JULY 6, 2001
E07

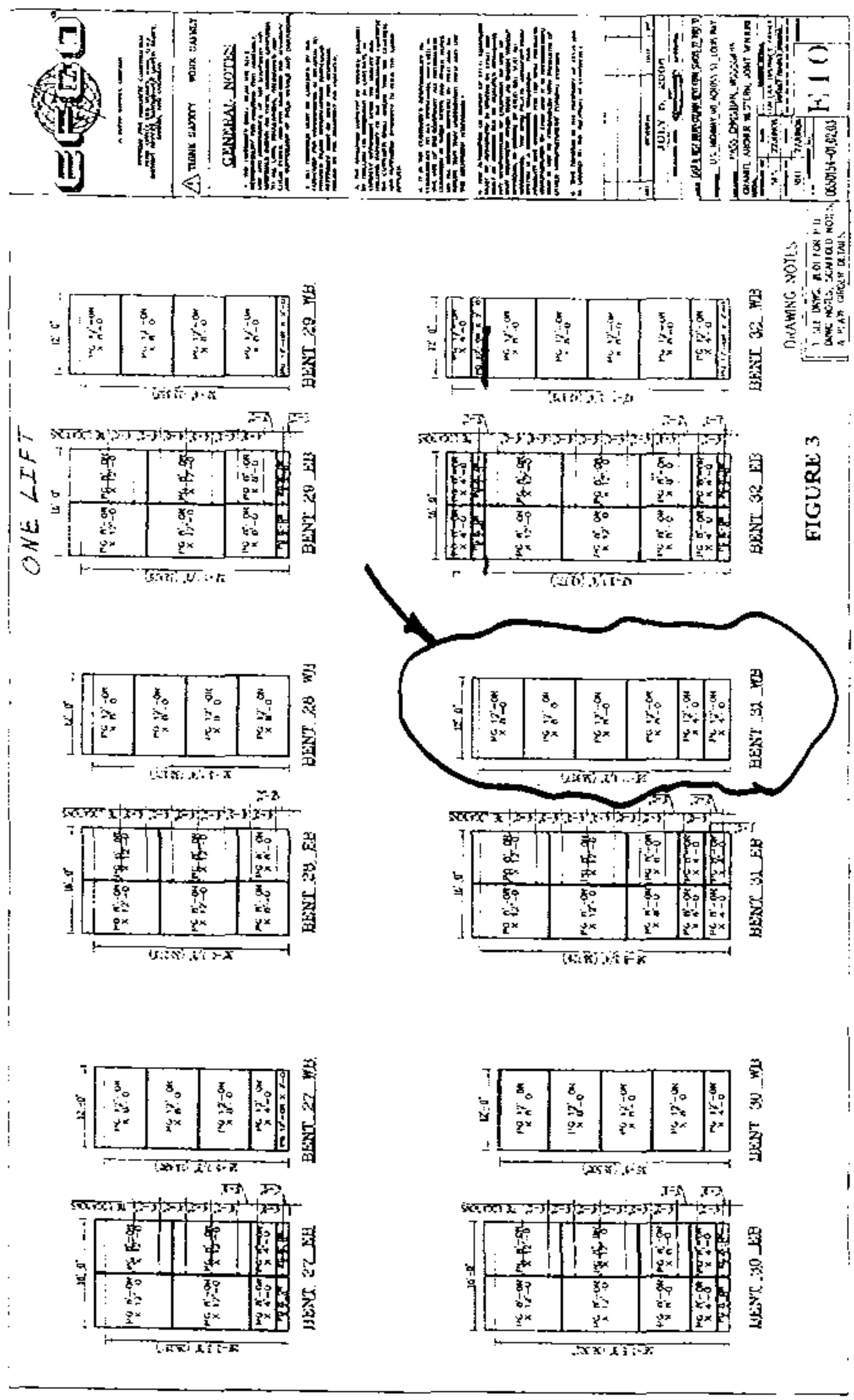



FIGURE 3

**FIGURE 4**

**FIGURE 5**

FIGURE 6

FIGURE 7

**FIGURE 8**

**FIGURE 9**

**FIGURE 10**

**FIGURE 11**

**FIGURE 12**

**FIGURE 13**

Specification Summary and QC Requirements

ATTACHMENT A
(SHEET 1 OF 1)

- **Construction Requirements**

  Place Pier columns and hammerheads in accordance with the plans and specifications.

- **Tolerance of Concrete Placement**

  Column to be incorporated into cap designs - shall not be shall not be out of position shown on plans by more than one inch.

- **Proportioning and Mixing Concrete for Caps, Pedestals, Closure Pours, etc.**

  Concrete shall be Class AA, 4,000 psi. (MMC Mix # G42000AA.)

- **Reinforcing Steel for Columns and Hammerheads**

  The following reinforcement shall be used in the caps as per MDOT 711.02:

  Black reinforcing steel.

  Bars shall be tied at all intersections except where spacing is less than one foot in each direction, alternate intersections shall be tied.

  Rebar shall have four inches clear from form edges on columns, and 2 inches clear from form edges on caps, typical. Chairs shall have plastic-coated tips.

  Burns, Cooley, & Dennis will perform rebar inspection before the concrete pour to ensure proper alignment.

- **Formwork Requirements**

  EFCO Plate girder forms will be used for columns and hammerhead caps.
  ¾" chamfer is welded to forms on all corners.

- **Handling and Placing Concrete**

  Concrete shall be placed in forms within 90 minutes from batching cement into mix. Maximum placement temperature shall be 95 DegF. Concrete shall be placed in lifts of less than 1.5 feet.

  No drops of concrete material over 5' in height. Consolidate with high-cycle internal vibrator throughout with minimum 2" vibrator head and re-insert vibrator every 5 feet (1.5 times 3.5 ft radius of action)

  Careful handling is required around form tie (she-bolts) and thermocouple wires.

  Burns, Cooley, & Dennis will perform concrete QC testing at each concrete placement.

- **Removal of Forms, Finishing, and Curing**

  Forms shall not be removed until the concrete has reached a minimum of 1000 psi for side forms and 2000 psi for soffit forms. (THIS IS SUPERCEDED BY MASS CONCRETE THERMAL MONITORING TIMEFRAMES).

# MISSISSIPPI DEPARTMENT OF TRANSPORTATION

*Inter-Departmental Memorandum*

TO: District Materials Engineer (16-30)
Wilson Ruff

DATE: 31 August 2006

FROM: Concrete Field Engineer
Adam Browne

SUBJECT CR PROJECT NO. ER-BR-0003-01(093)
104555-301000

INFORMATION COPY TO:

COUNTY: Hancock

| | |
|---|---|
| Central File | 89-20 |
| Construction Engineer | 73-01 |
| District Engineer | 26-01 |
| MDOT Project Engineer | David Seyfarth |
| Project Manager | Rodney Gray - URS |
| I.A.S. Branch | Frank Leatherwood |
| Concrete Section | Darryl Thompson |
| Contractor | Granite Archer Western |
| Concrete Producer | Gulf Concrete |
| Lab File | |

The class AA Portland cement concrete mixture listed below is tentatively approved for use on this project pending acceptable field verification data.

| MDOT's Mixture ID | SiteManager S&T Record ID | Concrete Producer's Mixture ID |
|---|---|---|
| AA67.0609700 | AA67.0609700 | G4200AAR |

Please see the attached mixture review and any additional information for specifics concerning the materials and mixture proportions.

**ATTACHMENT B**
**(SHEET 2 OF 3)**

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
Materials Division
Form for Approving Proportions of Portland Cement Concrete Mixtures

Project Units: English
Project Spec Section: 2004 MDOT 804
MDOT Mixture No.: [illegible]
Mixture Class: AA
Maximum Slump: 8 in
Design Slump: 5 in max.

PCC Producer: Gulf Concrete
PCC Producer's Mixture No.: G1[illegible]AAR
Specified Min. Strength: 4000 psi
Specified Air Content: 3 to 6 %
Basis of Proportioning: Laboratory Trial Batch

**MIXTURE PROPORTIONING**

| Material | Source | Description | Mix Quantity (SSD) (lb/yd³) | Bulk Specific Gravity | Mix Quantity (SSD) (lb/yd³) | Apparent Specific Gravity | Absorp. (%) | FM | Absolute Volume (ft³) | Status |
|---|---|---|---|---|---|---|---|---|---|---|
| Cement | HOLCIM - THEODORE | Type I/II/S | 468 | 3.15 | 468 | | | | 2.38 | Acceptable |
| Fly Ash | SEPARATION TECH [illegible] | Class F | 140 | 2.22 | 140 | | | | 1.01 | Acceptable |
| GGBFS | | | | | | | | | | |
| Other CM | | | | | | | | | | |
| Water | | | 235 | 1.00 | 235 | | | | 3.77 | |
| Fine #1 | [illegible] | Sand | 1173 | 2.61 | 1174 | 2.62 | 0.30 | 2.45 | 7.15 | |
| Fine #2 | | | | | | | | | | |
| Coarse #1 | [illegible] | #57 | 1772 | 2.48 | 1800 | 2.53 | 1.57 | | 11.4 | Acceptable |
| Coarse #2 | | | | | | | | | | |
| Coarse #3 | | | | | | | | | | |
| Air (%) | | | 4.5% | | 4.5% | | | | 1.22 | Acceptable |
| Total | | | 3785 | | 3817 | | | | 27.0 | Acceptable |

Water/Cementitious Material Ratio: 0.39 Acceptable

**CHEMICAL ADMIXTURE INFORMATION**

| Type | Supplier | Name | Dosage Range (fl. oz/cwt) | Dosage |
|---|---|---|---|---|
| AEA | BASF, INC. | AE 90 | [illegible] | [illegible] |
| Type A | BASF, INC. | POZZOLITH 322N | [illegible] | [illegible] |
| Type F | BASF, INC. | GLENIUM 3030NS | [illegible] | [illegible] |
| | | | [illegible] | [illegible] |
| Type D | BASF, INC. | POZZOLITH 100XR | [illegible] | [illegible] |

**BASIS FOR PROPORTIONING**

PREVIOUS FIELD EXPERIENCE

| Set Date | Cylinder Strength #1 | Cylinder Strength #2 | Average Strength |
|---|---|---|---|
| | | | |

10 Test Average Strength:
Standard Deviation:
Required Strength:
Status:

LABORATORY TRIAL BATCH

| Test | Results | Tolerance | Status |
|---|---|---|---|
| Slump | 5.00 | 5 ± 0.75 in | Acceptable |
| Air Content | 4.9 | 6 ± 0.5 % | Acceptable |

| Cylinder Strength | |
|---|---|
| Date | [illegible] |
| No. 1 | 5180 |
| No. 2 | 5220 |
| No. 3 | 5310 |

3 Test Average Strength: 5243
Required Strength: 5200
Status: Acceptable

**AGGREGATE ANALYSES**

FINE AGGREGATE

| | Fine #1 | Fine #2 |
|---|---|---|
| Dry Wt (g) | 325.7 | |
| Blend Pct | 100.00 | |

| Sieve | Accum. Wt. Retained | Accum. Wt. Retained | Total % Passing | Gradation Requirements |
|---|---|---|---|---|
| 1/2 inch | | | 100.0 | 100 |
| 3/8 inch | | | 100.0 | 97-100 |
| No. 4 | 2.9 | | 99.1 | 92-100 |
| No. 8 | 31.5 | | 90.3 | 75-100 |
| No. 16 | 64.2 | | 80.3 | 45-93 |
| No. 30 | 130.0 | | 60.1 | 25-79 |
| No. 50 | 278.0 | | 14.9 | 3-35 |
| No. 100 | 323.1 | | 0.8 | 0-10 |
| Pan | 325.7 | | | |

COARSE AGGREGATE  Size: #57

| | Coarse #1 | Coarse #2 | Coarse #3 |
|---|---|---|---|
| Dry Wt (g) | 6437.9 | | |
| Blend Pct | 100.00 | | |

| Sieve | Accum. Wt. Retained | Accum. Wt. Retained | Accum. Wt. Retained | Total % Passing | Gradation Requirements |
|---|---|---|---|---|---|
| 2 inch | | | | 100.0 | |
| 1-1/2 inch | | | | 100.0 | 100 |
| 1 inch | [illegible] | | | 100.0 | 100 |
| 3/4 inch | 158.4 | | | 98.2 | 85-100 |
| 1/2 inch | 1606.7 | | | 75.1 | |
| 3/8 inch | 3423.1 | | | 46.9 | 20-55 |
| No. 4 | 5845.8 | | | 9.2 | 0-10 |
| No. 8 | 6359.4 | | | 1.2 | 0-5 |
| Pan | 6438.5 | | | | |

Remarks: Acceptable. The permitted slump range is 5.5 to 8 in. The maximum concrete acceptance temperature is 95°F.

This mixture meets the requirements for moderate sulfate exposure and exposure to seawater.
The combined aggregate gradation falls into Zone II on the Modified Coarseness Factor Chart.

| Application Criteria for Sulfate Conditions |
|---|
| exposure to seawater |

| Application Criteria DS Mixtures |
|---|
| |

| FX Mixtures | | | | Air Content for DS/F/FX piling Exposed to Seawater | |
|---|---|---|---|---|---|
| Specified Strength | Min. Mass of Cementitious Material | Max. Mass of Water | w/cm | min | max |
| psi | lb | lb | | (%) | (%) |
| | | | | 3 | 6 |

ATTACHMENT B
(SHEET 3 OF 3)

## Gulf Concrete

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Customer | | Project: | | | | Lab # | 7 |
| Plant | | Notes: | Class AA-Limestone | | | Set # | |
| Date | 8/21/2006 | Mix Code: | G4200AAR f'c: | 4000 | Size(c.f.): 1.50 | Factor | 0.06 |

| Material | Vol. (c.f.) | SSD mix 1 cu. yd. Wt. (lbs.) | SSD mix lab batch Wt. (lbs.) | Adjusted lab batch Wt. (lbs.) | | | SSD Specific Gravity | Agg Absorption | Agg. FM |
|---|---|---|---|---|---|---|---|---|---|
| Cement | 2.38 | 408 | 26.0 | 26.0 | 26 | Holcim | 3.15 | | |
| Fly Ash | 1.01 | 140 | 7.8 | 7.8 | 7.8 | ProAsh | 2.22 | | |
| Sand #1 | 7.18 | 1174 | 66.2 | 67.0 | 67.0 | Sand (TXI 6-L-20) | 2.62 | 0.38% | |
| Sand #2 | 0.00 | 0 | 0.0 | 0.0 | | | 0.00 | | |
| Coarse agg | 11.45 | 1800 | 100.0 | 100.1 | 100.1 | #67 Gravel (TXI 6-L-1) | 2.52 | 2.30% | |
| Air 4.50% | 1.22 | 0 | | | | | | | |
| Water | 3.77 | 236 | 13.1 | 11.2 | 11.2 | | 1.00 | | |
| GGBFS | 0.00 | 0 | 0.0 | 0.0 | | | 2.63 | | |
| Other | | | | | | | | | |
| Total | 27.00 | 3817 | | | | | | | |

### ADMIX INFORMATION

| Type | oz /cwt | oz /cy | ml /cy | batch ml | actual ml | Brand / Name |
|---|---|---|---|---|---|---|
| Air | – | 0.80 | 23.7 | 1.3 | 1.3 | MB AE90 |
| WR | 2.0 | 12.2 | 359.6 | 20.0 | 20 | MB 322N |
| HRWR | 4.0 | 24.3 | 719.2 | 40.0 | 40 | MB GL 3000 |
| 100 XR | 3.0 | 18.2 | 539.4 | 30.0 | 30 | MB 100XR |

### Aggregate Moistures

| | Free h2o Content | Batch free h2o (lbs.) |
|---|---|---|
| Sand #1: | 2.77% | 1.8 |
| Sand #2: | | 0.0 |
| Coarse | 0.10% | 0.1 |

**Water Added/Withheld**

| +/- h2o | Added | W/held |
|---|---|---|
| | 0.0 | 0.00 |

### PLASTIC TEST RESULTS

| | | | |
|---|---|---|---|
| Batch Time | 9:06 AM | % Air | 5.90 |
| Sample Time | 9:15 AM | Unit Weight (pcf) | 140.38 |
| Slump, in. | 8 | Yield | 1.51 |
| Mix Temp | 89 | Initial set, min. | |
| Air Temp. | 73 | Final set, min. | |

### OTHER INFO

| | |
|---|---|
| Des. w/c | 0.39 |
| Act. w/c | 0.39 |
| Des.Un.Wt. | 141.37 |
| Sand/Agg | 0.85 |
| Bag Factor | 6.6 |

### Comments / Notes / Observations

Initial Set = 6 Hrs. 15 Mins.

### Strength Test Results

| Date | Age | psi | Avg. psi |
|---|---|---|---|
| | 4x8 CYLINDERS | | |
| 08/24/06 | 3 | 3930 | 3870 |
| 08/24/06 | 3 | 3810 | |
| 08/28/06 | 7 | 5190 | 5240 |
| 08/28/06 | 7 | 5220 | |
| 08/28/06 | 7 | 5310 | |
| 09/10/06 | 28 | | |
| 09/18/06 | 28 | | |
| 09/18/06 | 28 | | |

Technician who conducted tests: Bobby Dowdy

# REPORT OF FIELD TESTING OF CONCRETE

DATE 6-14-07

MIX CLASS: G4200AA R
START TIME: 0856
END TIME: 1:30

TOTAL YARDS PLACED: 153
PERSON PERFORMING TEST: D Tynes

| TEST# | CONCRETE SUPPLIER TICKET NUMBER | TIME DISPATCHED | TIME OF TEST | CUBIC YARDS OF CONCRETE | SLUMP | AIR CONTENT % | AIR TEMP | CONCRETE TEMP |
|---|---|---|---|---|---|---|---|---|
| 1 | 10914658 | 0856 | 0915 | 10 | 8 | 3.2 | 82 | 90.5 |
| LOCATION | Bent 9 WB Exp Dia 45+DS | | | | | | | |
| | WB Column Bent 31 | | | | | | | |
| 2 | 10916668 | 1117 | 1147 | 104 | 8 | 5.3 | 93 | 86 |
| LOCATION | | | | | | | | |
| 3 | | | | | | | | |
| LOCATION | | | | | | | | |
| 4 | | | | | | | | |
| LOCATION | | | | | | | | |
| 5 | | | | | | | | |
| LOCATION | | | | | | | | |

NOTE: APPLICABLE STANDARDS, UNLESS OTHERWISE INDICATED: MAKING SPECIMENS: T23-02 ; SLUMP: T119-99; AIR CONENT : T152-01); TEMPERATURE : T309-99; SAMPLING : T141-01

**REMARKS:**

Testing Company:
Alabama Scale & Instrument, Inc
1644 Varner Dr
Mobile, Al 36693

Performed For:
Gulf Concrete, LLC
Henderson Point
Pass Christian, Ms
Contact: Kenny Washington Phone: Fax:

| | |
|---|---|
| Manufacturer: | Alkon |
| Serial #: | 93737 |
| Equipment I.D. #: | Same |
| Model #: | Spectrum Version |
| Description: | Batch Controller |

| | |
|---|---|
| Calibration Date: | 6/15/2007 |
| Calibration Due Date: | 10/9/2007 |
| Calibration Interval: | 6 months |
| Calibration Procedure: | Manufacturers Specs. |
| Calibration Results: | |

Mississippi D.O.T Tolerance

| | |
|---|---|
| Cement | 2% |
| Aggregate | 2% |
| Water | 1% |
| Admixtures | 3% |

**Cement** Scale Capacity= 7,000 Tested Capacity= 5600

| Test | Suggest Test Load | Known Load | Sub-Load | Total Known Standard | Scale Result | Error | Tolerance = 2% | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Pass |
| 2 | 0 | 1000 | 0 | 1000 | 995 | -5 | 20 | Pass |
| 3 | 500 | 1000 | 515 | 1515 | 1510 | -5 | 30 | Pass |
| 4 | 1120 | 1000 | 1000 | 2000 | 1990 | -10 | 40 | Pass |
| 5 | 2240 | 1000 | 2180 | 3180 | 3170 | -10 | 64 | Pass |
| 6 | 3360 | 1000 | 3340 | 4340 | 4335 | -5 | 87 | Pass |
| 7 | 4480 | 1000 | 4410 | 5410 | 5405 | -5 | 108 | Pass |
| 8 | 5600 | 1000 | 5570 | 6570 | 6565 | -5 | 131 | Pass |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Pass |

**SAND** Scale Capacity= 25,000 Tested Capacity= 20000

| Test | Suggest Test Load | Known Load | Sub-Load | Total Known Standard | Scale Result | Error | Tolerance = 2% | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | | 0 | 0 | 0 | 0 | 0 | 0 | Pass |
| 2 | 1000 | 1000 | 0 | 1000 | 1000 | 0 | 10 | Pass |
| 3 | 2000 | 1000 | 2020 | 3020 | 3020 | 0 | 60 | Pass |
| 4 | 4000 | 1000 | 4000 | 5000 | 5000 | 0 | 140 | Pass |
| 5 | 6000 | 1000 | 6060 | 7060 | 7060 | 0 | 142 | Pass |
| 6 | 8000 | 1000 | 8120 | 9120 | 9120 | 0 | 182 | Pass |
| 7 | 10000 | 1000 | 10040 | 11040 | 11040 | 0 | 221 | Pass |
| 8 | 12000 | 1000 | 12180 | 13180 | 13180 | 0 | 264 | Pass |
| 9 | 14000 | 1000 | 14000 | 15000 | 15000 | 0 | 300 | Pass |
| 10 | 16000 | 1000 | 16160 | 17160 | 17160 | 0 | 343 | Pass |
| 11 | 18000 | 1000 | 18020 | 19020 | 19020 | 0 | 380 | Pass |
| 12 | 20000 | 1000 | 20060 | 21060 | 21060 | 0 | 421 | Pass |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Pass |

**ATTACHMENT D**
**(SHEET 2 OF 4)**

**Aggregate** Scale Capacity= 25,000 Tested Capacity= 20000

| Test | Stepped Test Load | Known Load | Sub-Load | Total Known Standard | Scale Result | Error | Tolerance = 2% | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | | 0 | 0 | 0 | 0 | 0 | 0 | Pass |
| 2 | 0 | 1000 | 0 | 1000 | 1000 | 0 | 20 | Pass |
| 3 | 2000 | 1000 | 2240 | 3240 | 3260 | 20 | 65 | Pass |
| 4 | 4000 | 1000 | 4000 | 5000 | 5000 | 0 | 100 | Pass |
| 5 | 6000 | 1000 | 6080 | 7080 | 7080 | 0 | 142 | Pass |
| 6 | 8000 | 1000 | 7980 | 8980 | 8980 | 0 | 180 | Pass |
| 7 | 10000 | 1000 | 10080 | 11080 | 11080 | 0 | 222 | Pass |
| 8 | 12000 | 1000 | 12100 | 13100 | 13100 | 0 | 262 | Pass |
| 9 | 14000 | 1000 | 14120 | 15120 | 15120 | 0 | 302 | Pass |
| 10 | 16000 | 1000 | 16140 | 17140 | 17140 | 0 | 343 | Pass |
| 11 | 18000 | 1000 | 18080 | 19080 | 19080 | 0 | 381 | Pass |
| 12 | 20000 | 1000 | 20000 | 21000 | 21000 | 0 | 420 | Pass |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Pass |

# ATTACHMENT D
## (SHEET 3 OF 4)

**1**

| MB AE 90 | START | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| Test 1 | -1 | 17 | 0 | 18 | 17 | 0 | 1 | Pass |
| Test 2 | -1 | 33 | 0 | 36 | 35 | -1 | 1 | Pass |
| | | | | | | | | |

**2** No test required

| DELVE | | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**3** Water Reducer

| 322N | START | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| Test 1 | 4 | 24 | 0 | 26 | 26 | 0 | 1 | Fail |
| Test 2 | 4 | 57 | 0 | 61 | 60 | -1 | 2 | Pass |
| | | | | | | | | |

**997** Not In Service

| | | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | | 106 | 0 | 106 | 100 | -6 | 3 | Fail |
| 2 | | 198 | 0 | 198 | 180 | -18 | 6 | Fail |
| | | | | | | | | |

**5** High Range Water Reducer

| GL3030 | START | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 104 | 0 | 104 | 104 | 0 | 3 | Pass |
| 2 | 0 | 304 | 0 | 304 | 300 | -4 | 9 | Pass |
| | | | | 0 | | | | |
| | | | | | | | | |

**6** Retarder

| 100XR | START | Known Standard | Sub-Standard | Computer Reading | Reference Standard | Error | Tolerance = 3% or Division size | Test Results |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 20 | 0 | 20 | 23 | 3 | 1 | Fail |
| 2 | 0 | 49 | 0 | 49 | 56 | 7 | 1 | Fail |
| 3 | 0 | 81 | 0 | 81 | 95 | 14 | 2 | Fail |
| | | | | | | | | |

ATTACHMENT D
(SHEET 4 OF 4)

## Weighed Water As Found

Scale Capacity= 2,000 Tested Capacity 1800

| | Known weight | Sub-weight | Total known weight | Scale Results | Error | Tolerance | Test Results |
|---|---|---|---|---|---|---|---|
| Test 1 | 1000.0 | 0 | 1000.0 | 1005 | 5.0 | 2.0 | Fail |
| Test 1 | 1000.0 | 545 | 1545.0 | 1545 | 0.0 | 3.1 | Pass |
| Test 2 | 1000.0 | 1050 | 2050.0 | 2055 | 5.0 | 4.1 | Pass |
| Test 3 | 1000.0 | 1560 | 2560.0 | 2560 | 0.0 | 5.1 | Pass |

## Weighed Water As Left

Scale Capacity= 2,000 Tested Capacity 1800

| | Known weight | Sub-weight | Total known weight | Scale Results | Error | Tolerance | Test Results |
|---|---|---|---|---|---|---|---|
| Test 1 | 1000.0 | 0 | 1000.0 | 1005 | 5.0 | 2.0 | Fail |
| Test 1 | 1000.0 | 545 | 1545.0 | 1545 | 0.0 | 3.1 | Pass |
| Test 2 | 1000.0 | 1050 | 2050.0 | 2055 | 5.0 | 4.1 | Pass |
| Test 3 | 1000.0 | 1560 | 2560.0 | 2560 | 0.0 | 5.1 | Pass |

Calibration equipment used:

| Company | Serial Number | Description |
|---|---|---|
| ASSI | ASSI-01-150-B | Class F Test weights |

This company maintains a quality system that meets or exceeds the requirements set forth in the following documents: [illegible] All calibration standards used by this company are traceable to NIST, [illegible] or to accepted ratiometric techniques. The expanded uncertainty of the calibration process should not exceed 25% of the acceptable tolerance given by the manufacturer specifications unless stated in the comments section above.

Technician License #: 809
Technician name: Jerry Suter
Signature: [signature]

# CONCRETE TEST LOG

(No Cylinders Made)

| | | | |
|---|---|---|---|
| **Project:** | U.S. 90 St. Louis Bay Bridge Replacement | **Page** | of Total Pages |
| **Project No.:** | 050916-CMT | **Contractor**(*circle one*): | Granite Archer Western / Landmark |
| **BCD Report No.:** | [redacted] (*assigned when typed*) | **Concrete Provider:** | Gulf Concrete (*circle plant*) (Henderson Point) / Bay St. Louis |
| **Sample Location:** | Bent # 21 Column W.B. Bent # 22-25 intermediate Diaphragms W.B. | **Concrete Mix Design:** | G 4290 AAK |
| **Sample Date:** | 6-14-07, 2007 | **Design Strength:** | 4,000 psi |
| **Technician(s):** | Craig Smith | **Notes:** | |

| | Truck No. | Ticket No. | CY Placed | Time: Batched | Time: Tested | Time: Placed | Slump (in.) | Air Content (%) | Temperature, °F: Ambient | Temperature, °F: Concrete |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 159 | 10916663 | 60 | 9:42 A | 9:57 A | 10:13 A | 7 ½" | 3.4% | 90° | 88° |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |

BURNS COOLEY DENNIS, INC.

ATTACHMENT E (SHEET 1 OF 1)