San Francisco – Oakland Bay Bridge
SELF-ANCHORED SUSPENSION (SAS) SPAN
San Francisco – Oakland Bay Bridge
SELF-ANCHORED SUSPENSION (SAS) SPAN

• Project Overview
• Conventional Vs SAS Bridge
• SFOBB SAS Features
• International Fabrication
• Temporary Bridge
• Shear Leg Crane
• Concrete Works
• Quality Program
  – Audits
  – Quality Plans
  – Mock-ups and Pre-qualifications
  – NCR Processing
  – In-process Tests and Inspections
  – Weld Tracking
Project Overview
October 17, 1989
Current East Span
Replacement Span

150 Year Service Life
1400 Year Earthquake
San Francisco-Oakland Bay Bridge (SFOBB)

Self-Anchored Suspension (SAS)

BID AMT: $1.41B
First Working Date: May 18, 2006
Estimated Completion Date: Spring 2013

West Approach
West Span
SAS
YBI Transition

San Francisco-Oakland Bay Bridge (SFOBB)
9 Bicycle/Pedestrian Facility
Summary Project Schedule

- Project General
- Bridge Deck
- Temporary Towers/Trusses
- T1 Tower
- Cable System
- W2 Cap Beam
- E2 Cross Beam
- Mechanical/Electrical
- Removal
Conventional Vs SAS

Bay Bridge Self-Anchored Suspension Tower Rendering
Conventional Suspension Bridge

- Two towers
- Two Main cables anchored to land
- Deck sections lifted in-place
Self-Anchored Suspension

- Need to build a bridge to build the bridge
- Bridge deck acts as compression member
- Transfer of deck loads to cable is last structural operation performed
SAS Features
SFOBB SAS

- Tower Height = 160 m
- Deck Length = 625 m
- Superstructure = 43,603,000 kg
T-1 Tower Layout

Tower Transverse Elevation

- Tower Saddle
- Elev 160m
- Tower Head
- Tower Saddle Grillage
- Tower strut
- Tower cross bracing
- "W" Line
- "E" Line
- Tower Skirt
- Tower Anchorage
- Top of Footing
- Q Bridge
- 6 @ 4 = 24m
- 3 @ 10 = 30m
- 3 @ 12 = 36m
- 7 @ 5 = 35m
- 5m
- 10m
One Tower (4 Legs) Seismic Shear Link Beams
Orthotropic Deck and Crossbeam

Typical Cross Section
Cable Installation

- Asymmetrical single tower
- One continuous main cable
- Bridge decks super-elevated and curved
- Load transfer not in free hanging position
- Final structural analysis will be “as-built” analysis
2020
5.4mm Zinc Galvanized Wire
127 Wire PWS Strand with Grease Application of Individual Wire
17,400 Wire Main Suspension Cable
Elastic Noxide Primer and Paint
Zinc Oxide / Zinc Dust Paste
Cable is made up of 137 PPWS Composition of SAS Cable
SAS Saddle Location (Total 6)

- 1 Tower Saddle
- 2 Deviation Saddles
- 2 Splay Saddles
- 1 Jacking Saddle
West Deviation and Jacking Saddles at W2

Status
¾ Developing pattern for "E" line segment 2
¾ Molding saddle for "E" line segment 1

- Hinge K
- Jacking Saddle
- Deviation Saddle
Bolted Splice Defined for Tower Skin Plate A
Bolting

- ASTM A490M bolts with Dacromet coating
- A490 bolts rarely used on bridges
- Coatings not allowed by current standard
- No rotational capacity criteria for metric

Bolting in confined space
International Fabrication

Bay Bridge Self-Anchored Suspension Tower Rendering
Fabrication Process

Japan

Saddles-Japan Steel Works

Korea

Suspender Cables-Kiswire
Bearings- Hochang Machinery Industries
Shear Key- Hochang Machinery Industries

Shanghai

PWS Cables-Shanghai Pujiang Cable Co

Washington

Tower Fabrication - ZPMC
Orthotropic Box Girder Sections - ZPMC
Bikepath - ZPMC

Minnesota

Pipe Beams-Oregon Iron Works

So. Calif

Misc Steel-D.S Brown & Westmont Industries

SAS - International Fabrication Effort
Superstructure Fabricator - ZPMC

Changxing Island Facility
Shanghai, P R China

New Tower Fabrication Shop
Tower
Orthotropic Box Girder

Submerged Arc Welding Gantry

U-Rib Bending Machine
Orthotropic Box Girder

OBG Lift Assembly

OBG Lifts Lined Up
Saddle Fabrication

JAPAN STEEL WORKS

Casting West Deviation Saddle
Saddle Fabrication Types:

Machining  West Deviation Saddle
Goodwin Steel Castings

Mock-up Casting

Pattern Shop
Temporary Bridge

Bay Bridge Self-Anchored Suspension Tower Rendering
Temporary Works

Facts
- 6,500 Mtons of Piling consisting of 48” x 1-1/4 and 42” x 1-1/2”
- 4,300 Mtons for Towers
- 5,500 Mtons Truss Material
- 2,124 Mtons of Driving Frames
Temporary Tower Foundations
Temporary Bridge
Shear Leg Crane
Shear Leg Crane and Barge

Lifting Capacity: 1700 Mtons
Boom Length: 100 Meters
Self-Erecting Boom
Shear Leg Crane
Concrete Works

Bay Bridge Self-Anchored Suspension Tower Rendering
Cable Tie-down Details

“E” Line  |  Ø Pier W2E

5000

Cap beam

Tie-down cables 61-15 Dia monostrand cables

Drain pipe, NPS 4 STD hot dip galvanized steel pipe, Typ

Tie-down Anchorage (By Others)

Tie Down

Ø Pier W2
W-2 Cap Beam

Facts
- 2,300 cubic meters conventional concrete
- 4,500 cubic meters self-consolidating concrete (8,700 PSI)
- 1,000 tons of rebar
- Dimensions: 55’W x 225’L x 22’D
E-2 Cross Beam

Facts

- 2,000 cubic meters self-consolidating concrete (8,700PSI)
- 650 tons of rebar
- Dimensions: 15’W x 200’L x 20’D
Quality Program
Facility Audits
Audits (40 performed to-date)

- Extensive in-depth facility audits
  - Audit checklist from lessons learned
  - Paperwork approval (English only) before audit
  - Facility audit
    - American standards
    - Verify capability and control/traceability throughout the process
    - Extensive international travel
    - Some doing work for Caltrans on other projects do not receive a pass for the SAS
    - Extends to lower tier subcontractors
  - Cannot start ANY work until passing an audit
  - Financial penalties for failing an audit
Quality Programs
QUALITY PLANS
(14 approved to-date)

• CONTRACT DOES NOT REQUIRE ONE COMPREHENSIVE ABFJV QC PROGRAM/MANUAL

• SPECIFIC CONTRACT QUALITY PROGRAM REQUIREMENTS
  – SEVERAL QC MANAGERS
  – SEVERAL QC PLANS
  – OTHER FABRICATION SPECIFIC PLANS (i.e., THERMAL CONTROL PLAN, PRECAST FENDERS, BEARING LUBRICANT, CABLE BAND SLIP, etc.)
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<th>Instll.</th>
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</table>

- = REQUIRED BY CONTRACT
O = RECOMMENDED BY ABFJV QC
- = NO REQUIREMENT
Mock-Ups and Prequalification
Completed ABF Tower Mock-Ups
Electroslag Weld trials
Cable Compaction
Cable Band Slip Test
W-2 Cap Beam
Integrated Shop Drawings

1. Prepared Using “Navisworks” Program by ABFJV Personnel (Michael Lewis)

2. Modeling of Approximately 30,000 Elements which includes:
   a. Reinforcing Steel
   b. Post Tensioning Ducts
   c. Embeds
   d. High Strength Rods for Main Hinge & Deviation Saddles

3. Resolved 30,000 conflicts which was almost one conflict per every element modeled
W-2 Cap Beam
Integrated Shop Drawings
Reinforcing Mechanical Coupler
Pre-qualifications
W-2 Cap Beam

Formwork for Mass Concrete Demonstration Pour

SCC Pour Mock-up

Spread Test Performed During Self Consolidating Concrete Pour Mock-up
NCR Processing

• Transition from serial letters with attachments to on-line document control process

• Lesson Learned – Technology is not the process. There need to be buy-in and commitments from all parties to make the system work
Creation of a Non-Conformance Report in PDF format
The NCR is transmitted to the Contractor
Quick search and status of all the Non-Conformance Reports and Non-Conformance Proposed Resolution reports
A complete suite of fully integrated modules that focus on the Engineering, Procurement and Construction (EPC) industry. PMIV was developed by project management experts from the need to better manage the various project functions.

PMIV allows you to program by objectives and manage by exceptions.

The Standard in Project Management

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+1 (925) 284-8302
In-Process Tests and Inspections
In-Process Tests and Inspections

• Coordination of inspection and testing activities
  – Numerous sub-consultant contracts
  – Domestic and international
  – Coordination with Caltrans
In-Process Tests and Inspections

• Welding Quality Control
  – Procedure Qualifications
  – Welding Quality Control Plan
    • Only AISC Category 3 facilities can self-perform welding NDT & inspection
  – Daily Reports
Welding QC Plan
AMERICAN BRIDGE/FLUOR
SFOBB BRIDGE PROJECT

QUALITY ASSURANCE SOFTWARE
WELDLINKPRO
Introduction

- Web based Quality tool developed using Microsoft’s ASP.NET and C# programming language. Designed to be utilized by Fabricator, Contractor and Owner specifically to document the fabrication of the San Francisco Bay Bridge Project.
- Real time reporting of inspections and repairs before, during and after welding by use of hand held devices and wireless network.
- Material traceability through the use of bar code technology and Material Data Log.
Introduction
(continued)

• Accountability of welders through tracking repair rates by welder, process, position, joint configuration and cause.

• Insures all required inspections and repairs have been completed in advance of shipment.

• Provides access via the world wide web to unlimited personnel to view the real time inspection and repair status.
Industries

- Bridge
- Aerospace
- Nuclear
- Hydroelectric
- Marine
- Military
- Construction
Highlights

- Material traceability
- Weld joint tracking
- Welder performance tracking
- Weekly Welding Report
- Documentation
- Benefits
- Contact information
Material traceability

- Material traceability is accomplished by use of bar code technology and/or traditional means of tracking items such as heat number and grade.
- Material information is compiled and stored on the Material Data Log as well as the Weld Data Log.
- Filtering allows the user to search by any desired combination of fields.
Material traceability
(continued)

• Material lists can be downloaded offsite for material on hand payments.
• Consolidated material list between parties.
• Individual plate traceability.
• Check sample verification
• PDF material test report
### Material Data Log

**PO #:** ORDER0001

**Ordered:** 1

**Material:** Plate

**Standard:** A709

**Length:** 1000

**Manufacturer:** Wyyang

**Supplement:** S7, S1, S2

**Ordered:** 10/1/2007

**Received:** 1

**Grade:** 250

**Line #:** 1

**Thickness:** 10

**Temperature Zone:** TI

### Receiving

**Received:** 10/2/2007

**Barcode:** PLATE001

**Lot #:** LCT001

**Heat #:** HEAT001

**Weight:**

**Place:**

**Approved Batch:** 34

**Receiving Status:** CT Accept

**Inspector:** Nate Lindell

**Plate ID:** PLATE001

**Reassign Barcode:**

**Cert #:**

**Batch #:**

**Width:** 100

**Contract #:**

**CT Lot #:**

**ZPMC Designation:** -- Choose ZPMC --

### Receiving Inspection

- MTR supplied?
- Weld repairs visible?
- FCM material?
- Markings in accordance with ASTM A6?
- Visually acceptable in accordance with ASTM A6
Highlights

– Material traceability
– Weld joint tracking
– Welder performance tracking
– Weekly Welding Report
– Documentation
– Benefits
– Contact information
Weld Data Log

- A centralized location for each weld joint on the project.
- Created prior to weld joint fit up.
- Outlines the required nondestructive testing.
- Outlines the required in process inspections per the contract requirements.
- Provides material traceability used to construct the weld.
- Works in conjunction with weld maps.
Weld Data Log
(continued)

- Insures proper acceptance criteria is applied.
- Eliminates costly re inspections
Weld Data Log

Report #: WLD002
Parent Report #: 
Job: Oakland Bay Bridge East Span
Origination Date: 10/13/2007
Completion Date: 
Weld ID: WELD_ID_2
Weld Map #: WELD_MAP_NUMBER_2
Drawing #: DRAWING_NUMBER_2
Barcode: WELD001
Repair Width: 

Originator: Mead, Josh
Status: 
Subassembly: SUB.ASSEMBLY_1
Assembly: DP
Segment: 2BE
Length: 1E
Repair Depth: 

Save

Weld Type

Weld Type: Complete Joint Penetration
Code: AWS D1.5-02
Weld Data Log
(continued)

• All inspection and repair reports are created via links from this central location.
• Captured data populates the weld reject log and daily production.
• Insures the correct acceptance criteria is applied during inspections.
• Eliminates the need for manual creation of reports reducing reporting errors.
### Base Metals

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### Repair History

No Repairs have been made
Weld Data Log (continued)

- History of all repairs associated to the weld
- Provides the positive proof all required inspections and repairs have been completed.
- Supports the creation of the weekly welding report.
- Supports and captures revisions to repair reports such as critical weld repairs.
- May be utilized during the review of the weekly welding report
### Base Metals

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### Repair History

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Highlights

– Material traceability
– Weld joint tracking
– Welder performance
– Weekly Welding Report
– Documentation
– Benefits
– Contact information
Welder Performance

- Welder performance is captured on the Weld Reject Log.
- Filtering allows the user to search by any desired combination of fields.
- Utilized for trend analysis of weld repairs.
- Provides real time total reject percentages project wide by any filterable field.
Welder Performance
(continued)

- Inspector
- Welder
- Repair type
- Weld identification
- Location in the structure
- Position
- Process
- Joint type
- Repair length
- Repair depth
- Repair width
- Repair percent
- Cause
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</table>
Highlights

– Material traceability
– Weld joint tracking
– Welder performance tracking
– Weekly Welding Report
– Documentation
– Benefits
– Contact information
Weekly Welding Report

- Weekly Welding Report is Compiled electronically following completion of tasks outlined on the Weld Data Log.
- Following review by the Quality Control Manager the Weekly Welding Report is submitted electronically to the Engineer for approval.
- During review by the Engineer the database may be available to verify current status of inspections and repairs.
Weekly Welding Report
(continued)

– Weekly Welding Report includes:
  • NDE reports
  • Critical Weld Repair Reports
  • Weld Repair Reports
  • Heat Straightening Reports
  • Nonconformance Reports
  • Weld Reject Log
  • Daily Production report
## Weld Report

**Structure:** OBG

**By Date:** 11/12/2007

**By Week:** 11/12/2007 - 11/19/2007 (Week #2)


**Viewing:** 11/16/2007 - Friday

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</table>
Highlights

– Material traceability
– Weld joint tracking
– Welder performance tracking
– Weekly Welding Report
– Documentation
– Benefits
– Contact information
Documentation

- Records can be viewed electronically or printed.
- Final acceptance of components is obtained by producing a Data Acceptance Packet.
- Data Acceptance Packets are compiled after completing a query and are produced in PDF format.
Documentation

- Data Acceptance Packet include the following:
  - Nondestructive Testing Reports
  - Weld Repair Reports
  - Post Weld Repair NDE Reports
  - Weld Map
  - Weld Data Log
  - Material Test Report
  - In process inspections as required
Highlights

- Material traceability
- Weld joint tracking
- Welder performance tracking
- Weekly Welding Report
- Documentation
- Benefits
- Contact information
Benefits

• Real time wireless accurate and consistent reporting of inspection and repair results.
• Electronic submittal process reduces the approval time and personnel.
• Increased level of traceability of material, inspections and repairs result in decreased time and involvement by the customer before, during and after fabrication including shipment.
• Eliminates costly re-inspections of previously inspected and accepted welds and components.
Benefits
(continued)

- Shared information between all parties at all locations through the use of web based application.
- Onsite reporting increases floor coverage and decreases office time.
- Increased level of accountability of welders and inspectors.
- Localization (bilingual)
- Eliminate redundant tracking by multiple parties.
Benefits
(continued)

- Reduced exposure for omitted and duplicate reports.
- Customer satisfaction by providing access to the database during the review and approval of the Weekly Welding Report.
- Reduce costly repairs through trend analysis
- May be implemented project wide
- Paperless submittal process
- Electronic report correlation and PDF printing
Summary

• Designed for the “Total Quality Management” approach this unique tool will greatly enhance traditional Quality Control and Quality Assurance reporting and documentation.
• Web based application opens the door for cooperation between Fabricator, Contractor and Owner.
• Increases accountability for welders, inspectors and reviewers.
• Captures valuable data that can be utilized to establish controls to reduce or eliminate defects.
• Provides complete material traceability from beginning to end.
Highlights

– Material traceability
– Weld joint tracking
– Welder performance tracking
– Weekly Welding Report
– Documentation
– Benefits
– Contact information
Contact information

Inspectech Corporation

8550 W Charleston Blvd #102-148 • Las Vegas, Nevada 89117 • 503-550-9918

www.Inspectechconsulting.com

Further product information on WeldLinkPro can be found at the following website

www.WeldLinkPro.com