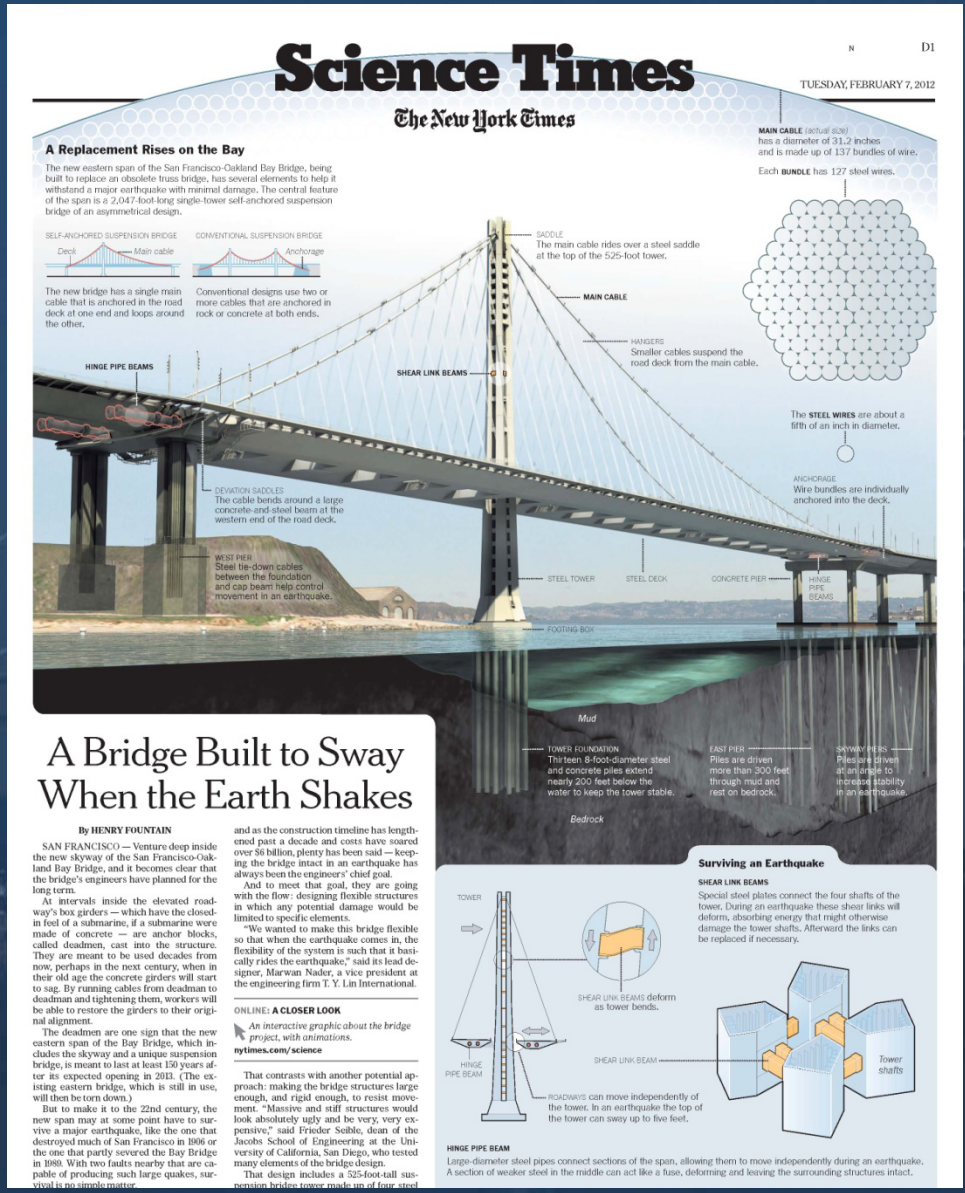
San Francisco-Oakland Bay Bridge East Span Seismic Safety Replacement Project Update



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A Replacement Rises on the Bay

The new eastern span of the San Francisco-Oakland Bay Bridge, being built to replace an obsolete truss bridge, has several elements to help it withstand a major earthquake with minimal damage. The central feature of the span is a 2,047-foot-long single-tower self-anchored suspension bridge of an asymmetrical design.

SELF-ANCHORED SUSPENSION BRIDGE — Deck, Main cable

The new bridge has a single main cable that is anchored in the road deck at one end and loops around the other.

CONVENTIONAL SUSPENSION BRIDGE — Anchorage

Conventional designs use two or more cables that are anchored in rock or concrete at both ends.

MAIN CABLE (actual size) has a diameter of 31.2 inches and is made up of 137 bundles of wire.

Each BUNDLE has 127 steel wires.

SADDLE The main cable rides over a steel saddle at the top of the 525-foot tower.

MAIN CABLE

HANGERS Smaller cables suspend the road deck from the main cable.

HINGE PIPE BEAMS

SHEAR LINK BEAMS

The STEEL WIRES are about a fifth of an inch in diameter.

ANCHORAGE Wire bundles are individually anchored into the deck.

DEVIATION SADDLES The cable bends around a large concrete-and-steel beam at the western end of the road deck.

WEST PIER Steel tie-down cables between the foundation and cap beam help control movement in an earthquake.

STEEL TOWER STEEL DECK CONCRETE PIER HINGE PIPE BEAMS FOOTING BOX

Mud

TOWER FOUNDATION Thirteen 8-foot-diameter steel and concrete piles extend nearly 200 feet below the water to keep the tower stable.

EAST PIER Piles are driven more than 300 feet through mud and rest on bedrock.

SKYWAY PIERS Piles are driven at an angle to increase stability in an earthquake.

Bedrock

A Bridge Built to Sway When the Earth Shakes

By HENRY FOUNTAIN

SAN FRANCISCO — Venture deep inside the new skyway of the San Francisco-Oakland Bay Bridge, and it becomes clear that the bridge's engineers have planned for the long term.

At intervals inside the elevated roadway's box girders — which have the closed-in feel of a submarine, if a submarine were made of concrete — are anchor blocks, called deadmen, cast into the structure. They are meant to be used decades from now, perhaps in the next century, when in their old age the concrete girders will start to sag. By running cables from deadman to deadman and tightening them, workers will be able to restore the girders to their original alignment.

The deadmen are one sign that the new eastern span of the Bay Bridge, which includes the skyway and a unique suspension bridge, is meant to last at least 150 years after its expected opening in 2013. (The existing eastern bridge, which is still in use, will then be torn down.)

But to make it to the 22nd century, the new span may at some point have to survive a major earthquake, like the one that destroyed much of San Francisco in 1906 or the one that partly severed the Bay Bridge in 1989. With two faults nearby that are capable of producing such large quakes, survival is no simple matter.

and as the construction timeline has lengthened past a decade and costs have soared over $6 billion, plenty has been said — keeping the bridge intact in an earthquake has always been the engineers' chief goal.

And to meet that goal, they are going with the flow: designing flexible structures in which any potential damage would be limited to specific elements.

"We wanted to make this bridge flexible so that when the earthquake comes in, the flexibility of the system is such that it basically rides the earthquake," said its lead designer, Marwan Nader, a vice president at the engineering firm T. Y. Lin International.

ONLINE: A CLOSER LOOK

An interactive graphic about the bridge project, with animations.

nytimes.com/science

That contrasts with another potential approach: making the bridge structures large enough, and rigid enough, to resist movement. "Massive and stiff structures would look absolutely ugly and be very, very expensive," said Frieder Seible, dean of the Jacobs School of Engineering at the University of California, San Diego, who tested many elements of the bridge design.

That design includes a 525-foot-tall suspension bridge tower made up of four steel

Surviving an Earthquake

TOWER

SHEAR LINK BEAMS deform as tower bends.

HINGE PIPE BEAM

SHEAR LINK BEAM

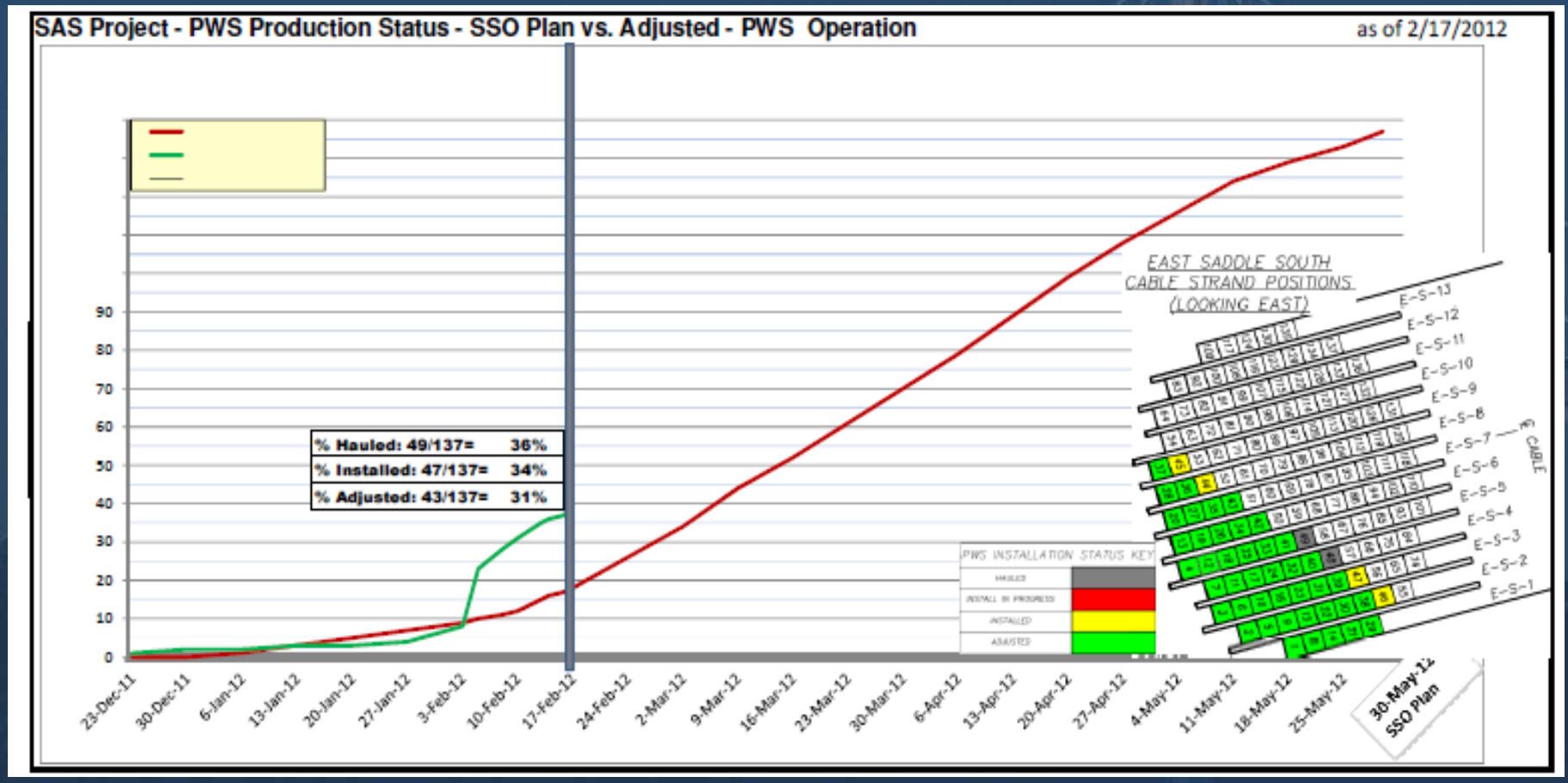
Tower shafts

ROADWAYS can move independently of the tower. In an earthquake the top of the tower can sway up to five feet.

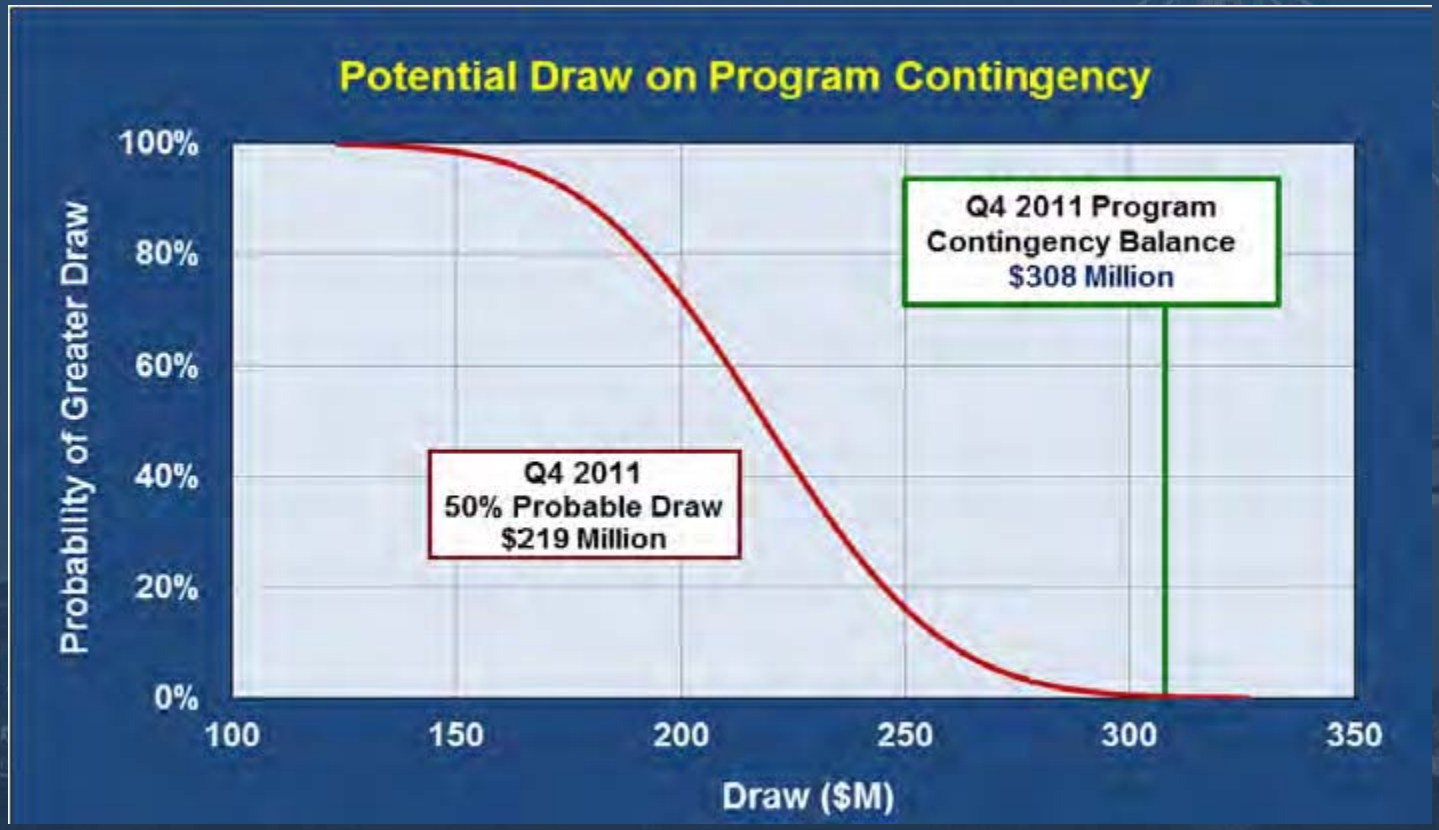
SHEAR LINK BEAMS Special steel plates connect the four shafts of the tower. During an earthquake these shear links will deform, absorbing energy that might otherwise damage the tower shafts. Afterward the links can be replaced if necessary.

HINGE PIPE BEAM Large-diameter steel pipes connect sections of the span, allowing them to move independently during an earthquake. A section of weaker steel in the middle can act like a fuse, deforming and leaving the surrounding structures intact.


GROVE
GROVE


SAS Project - PWS Production Status - SSO Plan vs. Adjusted - PWS Operation
as of 2/17/2012
% Hauled: 49/137= 36%
% Installed: 47/137= 34%
% Adjusted: 43/137= 31%
EAST SADDLE SOUTH
CABLE STRAND POSITIONS
(LOOKING EAST)
PWS INSTALLATION STATUS KEY
30-May-12
SSO Plan

Program Contingency



- **Funds available to address risks and accelerate project for more certain completion schedule**

Past Acceleration Actions

- Incentivized Fabrication and Shipment of Steel Roadway Boxes
- Construction of Oakland Detour to Eliminate Construction Conflicts

Acceleration Changes

- Transfers YBITS#1 Hinge K work to the SAS contractor, to make a single contractor responsible for area
- Provides additional resources for acceleration, including labor and equipment
- Adds incentives to complete critical work up to Hinge K by September 2012 and Seismic Safety Opening by Labor Day 2013

Forecasted Schedule Milestones

- Feb 2012 - Open Oakland Touchdown Detour (Westbound)
- Sep 2013 - Seismic Safety Opening (Both Directions)
- Sep 2015 - Permanent East-Bound On-ramp Opening
- Sep 2015 - Full Bicycle/Pedestrian Pathway Opening to YBI
- Jun 2017 - Complete Removal of Existing Bridge