SALVAGE OF THE BATTLESHIP USS UTAH FOLLOWING THE ATTACK ON PEARL HARBOR 1942-44
USS UTAH

USS UTAH was built at Camden, NJ in 1909-10.
- A 21,825-ton Florida Class battleship.
- Served in the Atlantic Fleet during World War I.
- Extensively modernized in 1925.
- Converted to a radio-controlled target ship in 1931.
Being down-graded to a target ship in 1931, the Utah was not retrofitted with torpedo bilges like the other older battleships at Pearl Harbor.
JAPANESE ATTACKED
NORTHWEST SIDE OF FORD ISL

The *Utah* was targeted *because* she was berthed where aircraft carriers were usually tied up on the weekends. She received two torpedoes.
The Utah was situated on the northwest side of Ford Island, where American carriers were usually berthed. Her decks were planked with heavy timbers because she was used as a target ship for the battle fleet. Efforts to prevent her capsizing failed and 58 were killed. Note ensign on fantail which was never fully raised.
Captain Homer N. Wallin, USN Naval Academy Class of 1917 Served initially on battleships Post graduate degree in Naval Architecture from MIT Prior to Pearl Harbor attack he was the Material Officer on staff of the Commander, Battle Force – Pacific ADM Nimitz promoted him to Captain and made him the Fleet Salvage Officer and Salvage Superintendent
Situation when salvage began-1942

Salvage efforts concentrated on the least damaged ships first, the *Oklahoma* and *Utah* were the last ships to receive serious attention.

Capsized hull of USS Utah
The Navy contracts with Pacific Bridge Company of San Francisco

- Refloating Methods Considered
  - Sealing the holes
  - Pontoons
  - Counterweight
  - Floating Dry Docks
  - Power winches on shore and rigging direct to the ship; This technique was previously employed to recover an overturned 19,000 ton caisson during construction of the Mid-Hudson suspension bridge at Poughkeepsie, NY in 1930-31
Subaqueous Materials beneath and around the USS Utah

Charles H. Lee of San Francisco was retained to determine the soil conditions and predict how the deformed mud would behave as the battleship was rolled over.
Plan view of Utah hull, viewed from offshore side
Cross sections through the Utah’s hull to verify overturning forces and anchor pull loads
Soil Mechanics Tests

1. Can sufficient passive resistance be developed under the ship to prevent sliding?

2. Recommend methods of stabilizing the soil to prevent sliding.

3. Can preliminary dredging be conducted without reducing friction to the point of sliding?

4. Will hull sink deeper in 120 and 90 degree positions?

5. Asked to perform model tests to confirm the assumed loads
Soil Conditions in Pearl Harbor

Legend

A  Soft Grey Clay, Mud or Silt
B  Soft Grey Clay, Mud or Silt with Coral Fragments, Sand & Shell
C  Medium Hard Brown Clay
D  Medium Hard Brown Clay with Coral Fragments, Sand & Shell
E  Coral Fragments or Sand & Shell sometimes with Clay
Exhaustive tests were conducted on a 1/96 scale model in a tank with soil from San Francisco Bay.

Soil shear testing results

Actual pull was within 5 percent of calculations

Line Pull Calculations
Soil mechanics test results

- Skin friction in mud = 400 lbs/ft²
- Skin friction in silty sand = 500 lbs/ft²
- Concerns for bow sliding
  - A max winch pull of 8,000 lbs
Passive Soil Pressures Controlled the Extraction Methodology

The model studies indicated rolling of the riveted hull rather than sliding on the soft bay muds, but there was concern about frame distortion of the riveted hull.
Final design of A-frame attachments to the overturned hulls

Soil from this area had to be progressively removed to allow final righting.
Cable pull 7,200 tons

Harbor surface

Cg = 23,800 tons

Mud line
Physical Factors that had to be modeled

- Naval Architecture – ship is not a rigid body
- Construction of A-frames, winches and pump systems
- Engineering – buoyancy considerations
- Skin friction of hull against harbor floor, whether mud or sand. Soil passive pressures
- Metallurgy of riveted frame and plate hull
Attempted Righting of the USS Utah

Fixed shore anchorages with power winches

A-frames
Winch Design

- 21 Compound pulleys
- 429 ton capacity each

- Motors had to respond precisely to individual control

- Operator stationed at each winch

- Variable-voltage drives

- 3” cable between the sheaves and the ship

- 1” steel cable on the winches
Salvage Choices

- Refloat hull using external floatation, similar to S-51 salvage in 1925-26
- Plug leaks and blow air into hull, similar to WW1 German fleet scuttled at Scapa Flow
- Scrap hulk in place by torching hull frames and plates
- Leave hulk as is, lose berth space
- Drag hull to deeper area or another part of Pearl Harbor and sink it
Mk V Deep Sea Diver rig was used in much of the underwater salvage work. Many of the salvage techniques used today were developed by these divers during World War II, who spent 2 to 3 years at Pearl Harbor; such things as arc welding underwater with 440 amps and using hydraulic jets to excavate tunnels beneath sunken hulls.
In the salvage of the Utah divers made 437 dives involving 2,227 man hours under pressure. There were only two diving supervisors.
All the diving and decompression on the sunken battleships never killed a military diver, but one diver lost his arm on the Oklahoma because the pumps were not under direct control of the diving supervisor.
Attempted righting of the USS Utah in 1944. The Utah was rotated back to within 35 degrees of horizontal, but left in place without being removed.
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