Why perched box caissons?

• Perched box caissons are used to construct the portion of the river piers that will support the steel arch spans.
• Construction can occur outside the “in water” work period because, unlike a coffer dam, the river bottom is not disturbed.
• The technique reduces environmental impacts and cost, and allows more schedule flexibility.
Sheet pile wall

Steel piling

Drilled shaft with rebar, concrete, and steel casing

Concrete slab
Step 1: Build Drilled Shafts

• In 2013 a subcontractor built four 10-foot diameter drilled shafts at each of the two main bents in the river (Bents 4 and 5).

• The drilled shafts will carry the weight of the bridge and traffic deep down into the solid rock under the silt and gravel of the river bottom.

• To build each shaft, the subcontractor first drilled a 10-foot round hole using a steel pipe, called a "casing," for the drill bit.

• When the bedrock beneath the river bed was encountered, a chisel weighing nearly 50,000 pounds was repeatedly dropped to break up the rock until a depth sufficient to support the bridge weight was reached.
Step 1: Build Drilled Shafts

• A crane lifted loose dirt and broken rock out of the hole as the drilling proceeded.

• A cage of steel reinforcing bars was lowered into the hole, and the hole was filled with concrete to finish the shaft.

• Because of the variable nature of the soil and rock beneath the river, no two shafts were of the same length.
  – At Bent 4, the shafts extend approximately 70 to 85 feet beneath the river bottom, reaching depths of about 104 feet beneath sea level.
  – At Bent 5, the bedrock is lower, and the shafts had to extend to almost 170 feet below sea level, or approximately 140 feet beneath the river bed.
Step 2: Assemble Box Caisson

• After the drilled shafts were completed, the project contractor assembled a box caisson around the shafts at each bent.

  – At Bent 4, the caisson is about 108 feet long in the north/south direction (parallel to the river), 22 feet wide in the east/west direction (at right angles to the river), and 30 feet tall.

  – The Bent 5 caisson is about 100 feet long by 22 feet wide by 30 feet tall.

• During assembly, the caissons have been supported on steel piles driven into the river bottom around the caisson during the in-water construction period.

• Each caisson has a concrete floor built in place around the drilled shaft casings. The caisson walls are built from steel sheet piling.
Perched Box Caisson

- Hydraulic jack
- Lowering support beam
- Sheet pile wall
- Steel piling
- Slab support beam
- Concrete slab
- Slab support beam
- Water level
- River bottom
- Jacking rod
- Shaft rebar
- Shaft casing
- Drilled shaft with rebar, concrete, and steel casing
Step 3: Sink Caisson

• Once each caisson is finished, it is lowered into the river using hydraulic jacks supported on piles around the caisson.
• Each caisson is lowered about 30 feet, with final elevation of the concrete floor at 4 feet below sea level.
• Water enters the caisson as it lowers into the river. As the caisson sinks, its floor will slide down along the drilled shaft casings.
Step 4: Anchor Caisson to Drilled Shafts

• After each caisson is sunk to its final elevation, divers working in the water inside the caisson connect the floor to the drilled shaft casings using "tiedown collars" and steel bolts.

• The tiedown collars are steel rings that are connected to the concrete floor and the steel casings.

• Rubber gaskets between the collars and the casings prevent river water from leaking into the caisson after the caisson is pumped dry.

• Divers working in the water outside the caisson attach the caisson to the surrounding piles. Once the caisson is securely connected to the shafts and piles, the jack system used for lowering the box is removed.
Perched Box Caisson lowered into position
Step 5: Dewater Caisson

• Next, the contractor pumps out the water that entered as the box was lowered into the river.

• Rubber gaskets between the collars and the casings prevent river water from leaking into the caisson after the caisson is pumped dry.
Perched Box Caisson sealed and dewatered

Seals around drilled shafts
Step 6: Build Bridge Bent
"In The Dry"

- Once the inside of the caisson is dry, the contractor will build the concrete bridge bent in the same way it would be done on land.

- First a crew installs steel reinforcing bars.

- Next, steel form panels are set up around the outline of the bent.

- Finally the forms are filled with concrete.

- When the concrete has cured, the form panels are removed.

- After forms are removed, workers apply a charcoal-colored stain to the concrete surfaces to give them an architecturally pleasing finish.
Perched Box Caisson ready for work

- Lowering support beam removed
- Shaft casing removed
River Pier Construction inside Perched Box Caisson

Rebar installed
Concrete placed inside Perched Box Caisson
Step 7: Flood Caisson

• After the concrete bent is finished, the contractor fills the caisson with water up to the level of the river outside the box.

• The purpose of flooding the caisson is to equalize water pressure on the inside and outside of the wall in order to remove the steel sheet piles that make up the walls.
Perched Box Caisson
allowed to flood
Step 8: Dismantle Caisson

• Once the caisson has been flooded, the contractor removes the sheet pile walls and support members.

• The caisson's concrete floor is left in place permanently attached to the bent.
Perched Box Caisson removed
River Pier complete
Step 9: Finish Bridge Construction

• After the concrete bents are built, the bridge's steel arch and roadway support structure will be constructed on the finished bents.

• Finally, the concrete roadway deck and sidewalks will be placed on the steel roadway supports.
Steel arch rib

Concrete river bent (pier)