Composite Arch Bridge System

Installation Handbook

June 13, 2014

Contents

Composite Arch Bridge System ......................... 1
I. INTRODUCTION ................................................. 2
I. CONSTRUCTION EQUIPMENT SELECTION .2
II. CRAFT LABOR................................................... 2
III. SCHEDULE DURATIONS............................... 2
IV. HANDLING and SETTING ARCHES .............. 3
V. DECKING ..................................................... 4
VI. ARCH CONCRETE EMBEDMENT............... 5
VII. ARCH CONCRETE PLACEMENT............... 5
VIII. HEADWALL INSTALLATION ................... 6
IX. BACKFILLING AND BARMATS............... 6
X. MATERIAL CHECKLIST ............................... 7
XI. TOOL CHECKLIST ................................. 7
I. INTRODUCTION

The purpose of this handbook is to provide a General Contractor an overview of the sequence of operations involved in building the Composite Arch Bridge System.

Although every project will have a unique set of contractual documents with plans, specifications, and testing/inspection requirements, the intent is to provide a summary of operations and overall requirements for planning work.

Due to a variety of designs for bridge foundations and abutments, the focus of this handbook is limited to the construction operations of: handling and setting arches, installing decking, placing the self-consolidating arch concrete, and construction of headwalls.

When applicable, the basis for determining the sequence and duration of operations was from prior experience in building Composite Arch Bridge Systems. The crew size was selected based on optimal performance.

II. CONSTRUCTION EQUIPMENT SELECTION

Typically, a light equipment is used to set the arches and install the decking. The equipment's reach needs to exceed the center (apex) of the arches so that they can easily be set. The hollow arch weight for a 12" diameter 50 foot span is approximately 200 pounds, and the same arch made out of 15" diameter would weigh 250 lbs. Thus, two men can easily lift and adjust the arches to their final position.

A concrete pump truck with a boom that can reach the apex of the arch is required for infilling the arches with concrete.

A loader/forklift is needed for unloading the arches from the transport truck, material handling, and leveling equipment work areas.

III. CRAFT LABOR

The general craft skill requirements of a working crew are: surveyor, light construction equipment operator, and four construction laborers, although two laborers might be sufficient in some cases. Typically, a working superintendent will have the skills necessary for surveying and operating equipment.

III. SCHEDULE DURATIONS

Given a 50 foot wide bridge with geometry of 50 foot span, and 10 feet arch rise elevation (above top of abutment) a representative duration for the following construction activities is:

Arch Setting (12" diameter): 12 arches per eight-hour crew operation with six-man crew.
FRP Deck Installation 20 panels per eight-hour crew operation with six-man crew.

Arch Embedment Concrete Placement: four-hour crew operation placement with four-man crew (excluding concrete truck driver and concrete pump operator); plus 2 day cure time before subsequent operation other than light foot traffic on decking. Note that in cases of small or no water passage, the arch embedment can be part of a single foundation pour.

Arch Concrete Placement: two-hour crew operation with two-man crew (excluding concrete truck driver and concrete pump operator); plus 2 day cure time before subsequent operations other than light foot traffic on decking.

Headwall Placement and Bracing: For and FRP headwall system, eight-hour crew operation with four-man crew; may vary if a crane is required.

**IV. HANDLING and SETTING ARCHES**

Planning receipt of arches should be as close to the installation date as possible to minimize the risk to damage during on-site storage.

Arches are stacked, crated with blocking as a unit (typically seven stacked arches due to transport height limitations) and shipped in a trailer from the fabricator. The arches crate is unloaded using a crane spreader bar or forklift.

Disassembling arches from the crate is done by hand. The blocking must be returned to the fabricator. Relocating arches to store or set in place by crane requires two nylon 3” wide endless sling straps separated by at least six feet.

Arches are placed into the abutment by restraining (fixing) one end and allowing free horizontal movement at the other end until FRP decking installation is complete. This approach
allows for minor movement of the arches, ensuring adequate arch-to deck connection.

Restraining is accomplished by using wire ties and fixing the arch end (via the arch positioning bar) to the abutment rebar cage at the specified location /elevation.

Wooden spacers and ratcheting nylon straps can be used to maintain the specified arch spacing prior to and during FRP deck installation.

V. DECKING

After the arches have been positioned, the first FRP decking panel can be connected to the arches.

Shown above, a light crane may be necessary during deck installation (a deck panel weighs roughly 7 pounds per foot making a 40ft panel weigh around 280 pounds)

Special care is needed in positioning the first panel level using a transit. The panels are then attached to the arches using specified stainless steel fasteners along the spine of the arch. A battery drill with clutch is required since care must be taken not to strip holes when fastening the deck.
After positioning the first panel, the operation is continuous from one abutment to the other. As the final panel is set, the free to-move arch ends are fixed into the rebar tie. As a reminder, one of the arch ends is fixed in the abutment before paneling operation begins whereas the opposite end is free to move, to account for slight variations in arch geometry.

On skewed bridges, the ends of the panels are then cut parallel to the end arches using a reciprocating saw and portable grinder. Care must be taken not to damage the end arches during this operation.

VI. ARCH CONCRETE EMBEDMENT

After the arches and decking have been set, the abutments can be completed.

When the foundations are done in multiple placements, the compressive strength of the prior placement must reach specification before the second placements occurs. Note that there are situations (i.e. with low or no water passages) where the arches can be embedded directly into the foundation within a single pour as shown below.

No other work operation on the deck beyond workmen walking on the deck can occur until the arch embedment concrete cures to the specified strength.

VII. ARCH CONCRETE PLACEMENT

The concrete required in this operation is a self-consolidating concrete (SCC). The SCC mix includes a shrinkage compensating admixtures (SCA), a viscosity modifying admixtures (VMA), a hydration stabilizer (retarder) and a superplastisizer (high range water reducer). A
mix design with proven performance needs to be submitted to the engineer for approval.

Flowability of the SCC mix is field tested by measuring slump flow. Typically slump flow (measured as diameter of the concrete spread) is between 24” and 30”.

A concrete fill box has been used successfully to facilitate the concrete operations through the fill hole at the apex of the arches. This fill box allows for flow control and topping off operations, while minimizing concrete overflow and spillage. A maximum of two workmen are allowed at the apex of the arch while it is being filled.

Vent holes are located 18”-24” on either side of the arch fill hole and must be unobstructed during concrete filling.

A continuous concrete arch fill operation is required. No partial truck load is allowed in an arch fill operation.

After the arch concrete placement, no other work activities are allowed for 48 hours. Only light foot traffic is allowed over the decking until the arches have reached their desired compressive strength.

VIII. HEADWALL INSTALLATION

After the arches have cured for 24 hours, the headwall panels may be erected and braced into position. Headwall options vary and details will be project specific.

IX. BACKFILLING AND BARMATS

Once the concrete deck has cured for 24 hours, the structure can be backfilled using maximum lifts of 12” with a maximum deviation of equal backfilling of 24”. Install drainage as necessary during backfill. Attach fascia plate if necessary.

After backfilling is completed to finish grade, work can begin on guardrails and paving.
X. MATERIAL CHECKLIST

A. Arches
B. Decking
C. Self drilling stainless steel screws to fasten deck to arch
D. Headwall
E. 1” Ratcheting nylon tie-down straps
F. Scaffolding
G. Lumber for spacers, jigs and formwork
H. Standard construction fasteners (screws and nails for temporary formwork and bracing)

XI. TOOL CHECKLIST

A. Laser/Transit Level for measuring elevations
B. Portable generator for small tools
C. Battery operated drills with clutch adjustment with back-up batteries (including drill, screw and hole saw attachments).
D. Circular saw
E. Reciprocating saw with wood and carbide tip blades (used to cut deck panels if necessary)
F. Extension and step ladders
G. Standard concrete finishing tools
H. Standard construction small tools