

# ALTERNATIVE TO TRADITIONALLY BUILT BRIDGES and BOX CULVERTS



## CONCRETE ARCH STRUCTURES



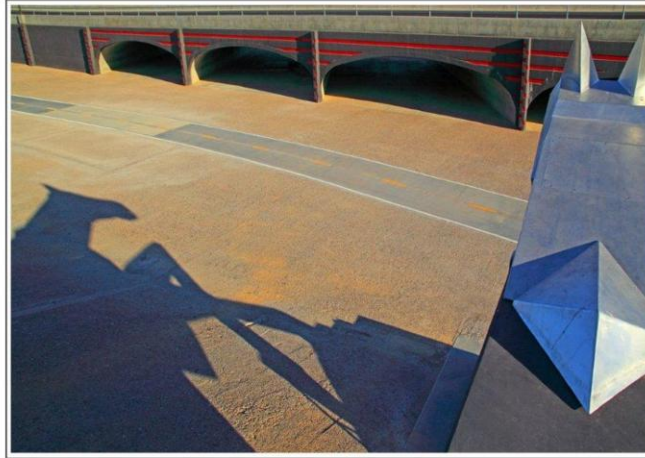
## HISTORY OF THE ARCH



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## TODAY'S ARCH





## THE ARCH ADVANTAGE

Strength of the arch geometry

Design/build process

Designed to support AASHTO HS-20 loads

Efficient construction methods

# CONSTRUCTION

## **Foundation Construction**

Steel Arch Forming System

Concrete Placement

Removal/Recycling of Forms

Backfill within 48 hours

Decorative Treatment



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Backfill within 48 hours

**Decorative Treatment**



# AESTHETICS

## COLORED OR PAINTED CONCRETE



# AESTHETICS

## FORM LINER



## AESTHETICS ROCK OR STONE



# AESTHETICS

## ENDLESS POSSIBILITIES





# AESTHETICS

TILED CEILING, GLASS BLOCK,  
TERRAZZO FLOOR





## THE ARCH ADVANTAGE

SAVINGS – COST AND TIME

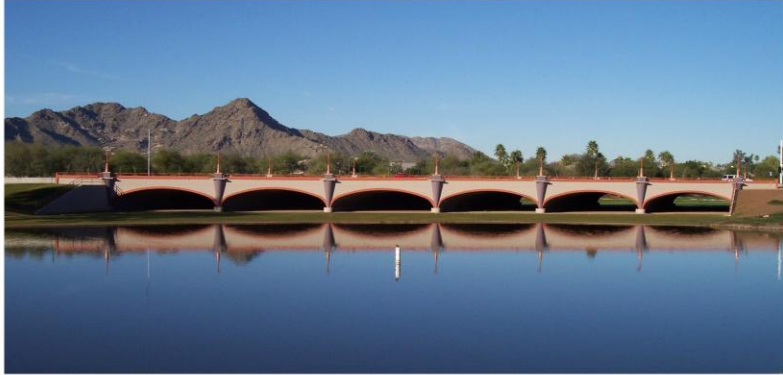
10% - 30% over other technologies

Less Material

Faster Forming, Stripping and Backfilling

Various arch uses

## VALUE ENGINEERING OVER \$1 MILLION



## VALUE ENGINEERING OVER \$400,000



## VALUE ENGINEERING OVER \$250,000



## EQUESTRIAN UNDERPASS



## PEDESTRIAN UNDERPASS



## USACE FLOOD CONTROL





## PRECAST BRIDGE



## PRECAST PEDESTRIAN UNDERPASS





## COST COMPARISON CASE STUDY

2 STANDARD DESIGN STRUCTURES ON THE  
PROJECT

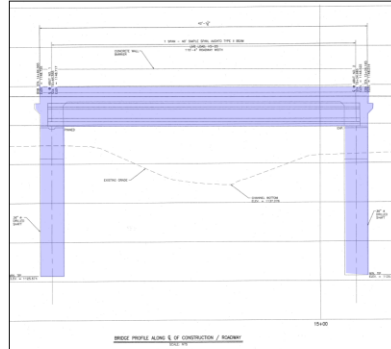
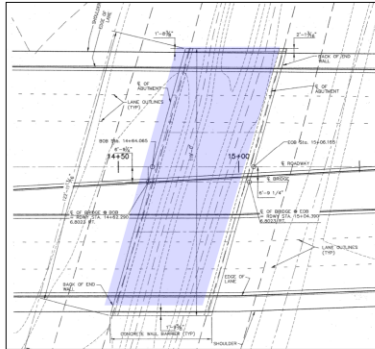
ONE STANDARD AASHTO GIRDER BRIDGE

ONE ADOT REINFORCED CONCRETE BOX  
CULVERT

VALUE ENGINEERED ARCH STRUCTURE TO  
REPLACE THE STANDARD DESIGN BRIDGE  
AND BOX CULVERT STRUCTURES

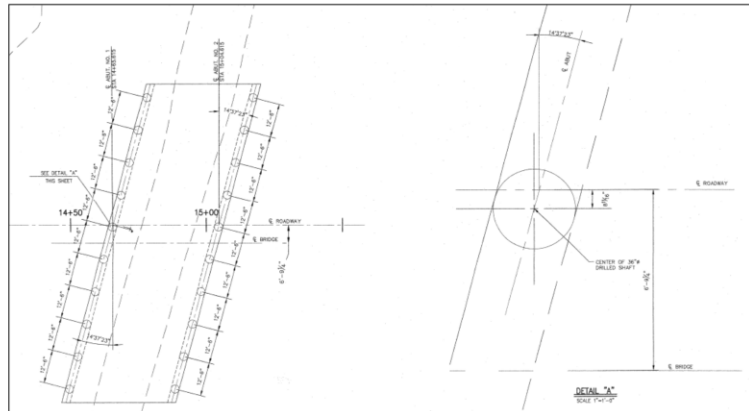
# GIRDER BRIDGE DETAILS

42 Foot (12.8m) span by  
123 feet (37.5m) long structure



# GIRDER BRIDGE DETAILS

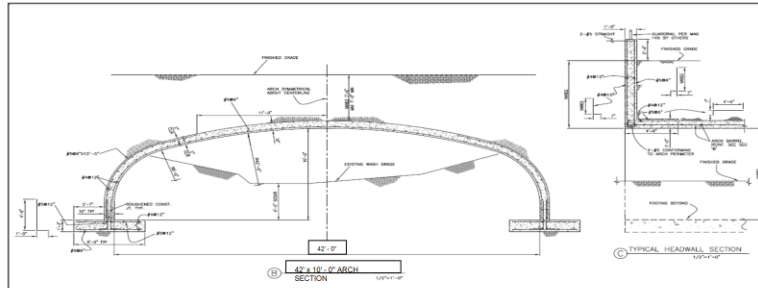
20 each 36 inch drilled shafts



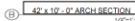
# GIRDER BRIDGE DETAILS

# ARCH DETAILS

42 Foot span by 123 foot long structure



Spread footing to minimize impact to environmentally sensitive areas





# ARCH VS. GIRDER BRIDGE COST COMPARISON

| GIRDER BRIDGE                             | QUANTITY | UNIT | UNIT \$           | TOTAL \$          |
|---|----------|------|-------------------|-------------------|
| DRILLED SHAFT (INSTALLED)                 | 291      | LF   | \$ 98.00          | \$ 28,518         |
| BUY / SET GIRDERS                         | 814      | LF   | \$ 265.00         | \$ 215,710        |
| REINFORCING STEEL (BRIDGE/APPROACH SLABS) | 50,935   | LB   | \$ 1.25           | \$ 63,669         |
| CLASS A CONCRETE 3000 PSI                 | 417      | CY   | \$ 220.34         | \$ 91,882         |
| DECK CONCRETE                             | 129      | CY   | \$ 308.03         | \$ 39,736         |
| STRUCTURAL BACKFILL                       | 600      | CY   | \$ 13.02          | \$ 7,812          |
| CONCRETE APPROACH SLAB                    | 3,690    | SF   | \$ 10.30          | \$ 38,007         |
| BRIDGE MISCELLANEOUS                      | 417      | CY   | \$ 67.50          | \$ 28,148         |
| STRUCTURES MOBILIZATION                   | 1        | LS   | \$ 7,000.00       | \$ 7,000          |
| <b>GIRDER BRIDGE TOTAL</b>                |          |      |                   | <b>\$ 520,481</b> |
| <b>ARCH STRUCTURE</b>                     |          |      |                   |                   |
| ARCH FOUNDATION EXCAVATION                | 1,500    | CY   | \$ 7.85           | \$ 11,775         |
| PREFAB ARCH/WALLS/FOOTING FORMS           | 17,721   | SF   | \$ 0.58           | \$ 10,278         |
| CONCRETE PURCHASE                         | 497      | CY   | \$ 76.00          | \$ 37,772         |
| REINFORCING STEEL                         | 85,867   | LB   | \$ 0.85           | \$ 72,987         |
| FOUNDATION CONCRETE                       | 1,922    | SF   | \$ 30.66          | \$ 58,929         |
| ARCH CONCRETE                             | 295      | CY   | \$ 112.54         | \$ 33,199         |
| WING & HEADWALL CONCRETE                  | 134      | CY   | \$ 298.40         | \$ 39,986         |
| ARCH MISCELLANEOUS                        | 510      | CY   | \$ 89.82          | \$ 45,808         |
| ARCH ENGINEERING                          | 1        | LS   | \$ 16,300.00      | \$ 16,300         |
| ARCH EQUIPMENT MOBILIZATION               | 1        | LS   | \$ 19,000.00      | \$ 19,000         |
| BACKFILL ARCH STRUCTURE TO SUBGRADE       | 4,300    | CY   | \$ 10.49          | \$ 45,107         |
| ADDITIONAL ROADWAY SURFACE                | 722      | SV   | \$ 23.00          | \$ 16,606         |
| <b>ARCH BRIDGE TOTAL</b>                  |          |      |                   | <b>\$ 407,747</b> |
| <b>COST SAVINGS</b>                       |          |      | <b>\$ 112,734</b> | <b>22%</b>        |



## ARCH VS. GIRDER BRIDGE COST COMPARISON

*The bridge deck surface area is 5,166 sf.*

*The girder bridge cost of \$520,481 equals \$101 per sf*

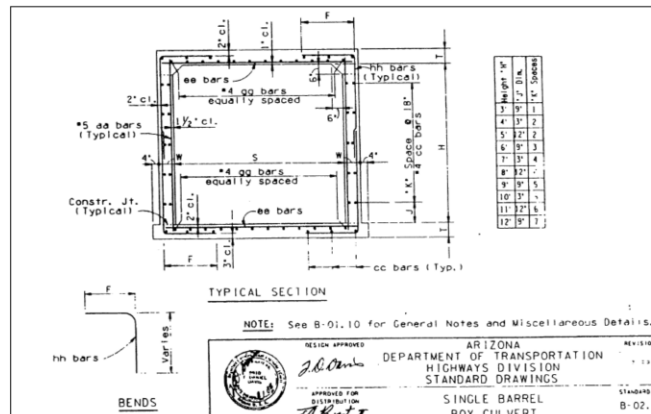
*The Arch cost of \$407,747 equals \$79 per sf*

**A 22% SAVINGS !**

# BOX CULVERT DETAILS

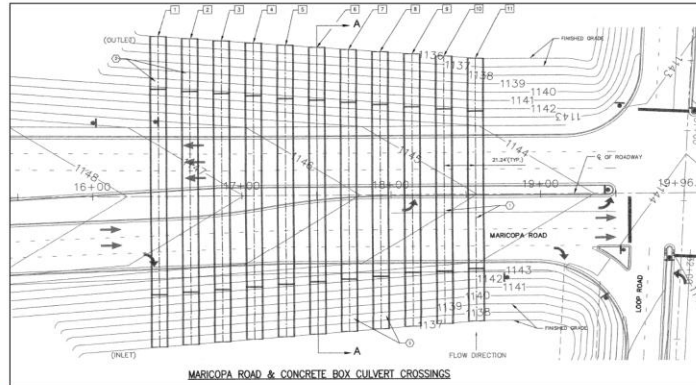
## Arizona Department of Transportation

### Standard B-02.10



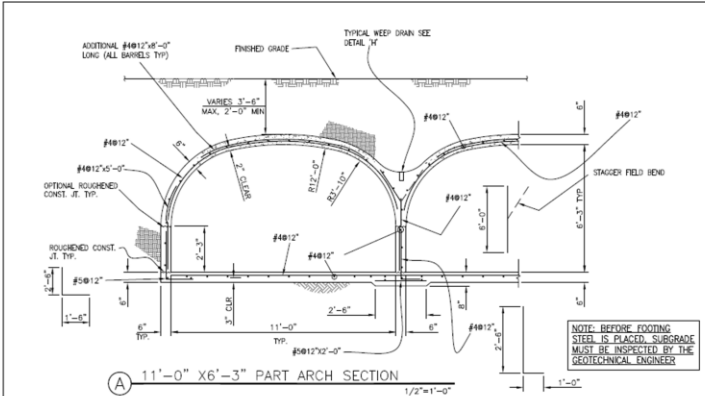
# BOX CULVERT DETAILS

11 cell – 10 foot span x 6 foot tall culvert  
with varied lengths



# ARCH CULVERT DETAILS

Utilized a multi-cell arch design with a floor similar to the box culvert. The wing walls and aprons were identical to the box.



## ARCH CULVERT VS. BOX CULVERT COST COMPARISON

| REINFORCED CONCRETE BOX CULVERT              | QUANTITY | UNIT | UNIT \$     | TOTAL \$          |
|--|----------|------|-------------|-------------------|
| STRUCTURE EXCAVATION                         | 2,106    | CY   | \$ 6.06     | \$ 12,762         |
| EXCAVATE CUT-OFF WALLS & FINE GRADE          | 22,610   | SF   | \$ 2.76     | \$ 62,404         |
| REINFORCING STEEL (BOX CULVERT)              | 381,000  | LB   | \$ 0.80     | \$ 304,800        |
| INVERT CONCRETE (FLOOR)                      | 833      | CY   | \$ 164.35   | \$ 136,904        |
| BARREL & WING WALL CONCRETE                  | 1,352    | CY   | \$ 219.65   | \$ 296,967        |
| STRUCTURES MOBILIZATION                      | 1        | LS   | \$ 7,000.00 | \$ 7,000          |
| <b>REINFORCED CONCRETE BOX CULVERT TOTAL</b> |          |      |             | <b>\$ 820,836</b> |

| ARCH CULVERT                        | QUANTITY | UNIT | UNIT \$      | TOTAL \$          |
|-------------------------------------|----------|------|--------------|-------------------|
| STRUCTURE EXCAVATION                | 2,106    | CY   | \$ 6.06      | \$ 12,762         |
| EXCAVATE CUT-OFF WALLS & FINE GRADE | 22,610   | SF   | \$ 2.76      | \$ 62,404         |
| REINFORCING STEEL (BOX CULVERT)     | 215,319  | LB   | \$ 0.80      | \$ 172,255        |
| INVERT CONCRETE (FLOOR)             | 820      | CY   | \$ 170.35    | \$ 139,687        |
| BARREL & WING WALL CONCRETE         | 715      | CY   | \$ 236.29    | \$ 168,947        |
| ARCH ENGINEERING                    | 1        | LS   | \$ 23,000.00 | \$ 23,000         |
| ARCH EQUIPMENT MOBILIZATION         | 1        | LS   | \$ 15,000.00 | \$ 15,000         |
| <b>ARCH CULVERT TOTAL</b>           |          |      |              | <b>\$ 594,056</b> |

COST SAVINGS \$ 226,781 28%



## ARCH CULVERT VS. BOX CULVERT COST COMPARISON

*The box culvert length is 2264 lf.*

*The box culvert cost of \$820,836 is \$362 per lf*

*The Arch culvert cost \$594,056 is \$262 per lf*

**A 28% SAVINGS**

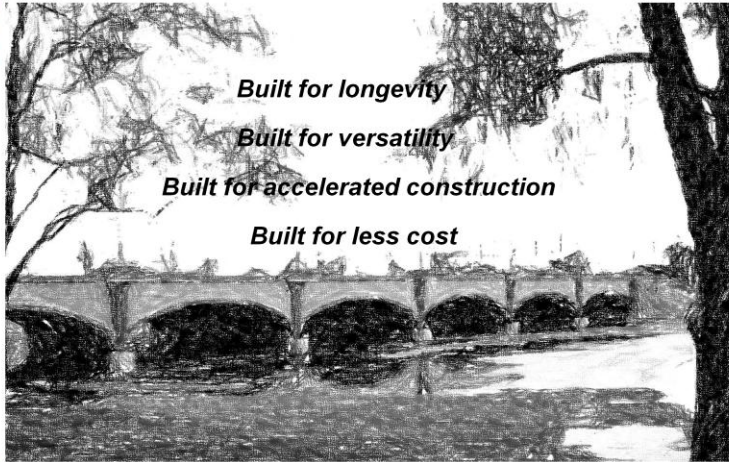
# ARCH CULVERTS

*Built for longevity*

*Built for versatility*

*Built for accelerated construction*

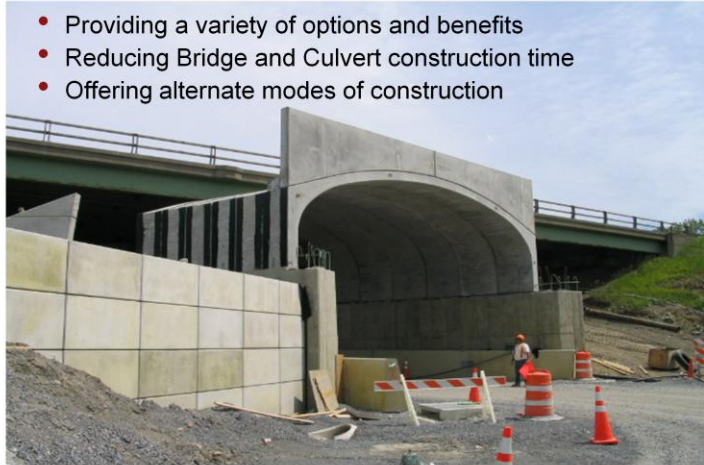
*Built for less cost*





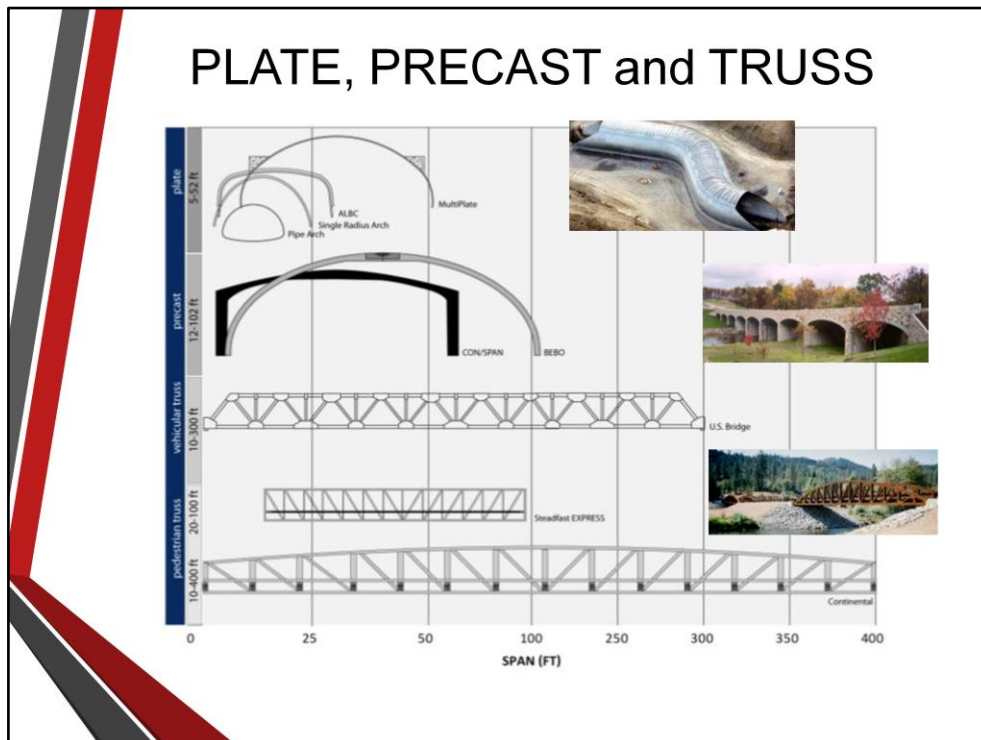
# ACCELERATED BRIDGE CONSTRUCTION

- Providing a variety of options and benefits
- Reducing Bridge and Culvert construction time
- Offering alternate modes of construction



# OPTIONS





Just like pipe, you may be overwhelmed with all the Bridge Systems. When do I use Plate...When do I use Truss? Although there isn't a one size fits all solution and the type of system will depend on your specific project, one place to start is working with your CONTECH PC, who can help evaluate your site and assist in structure selection.

Here are the specifics on where each bridge type fits into a span range. For example in Plate, spans range from 5 ft. to 52 ft., whether round or open, box or round or some other configuration that we'll talk about in just a moment. Precast goes from 12 to 102 ft. and the vehicular truss structures that we're involved with can really start anywhere, but the fact that it will probably be in the range of 10-20 ft. up to 150 ft. for vehicular. Pedestrian bridges will take you from say 10-20 ft. to in excess of 250 ft. Spans larger than 250' are typically cable stayed bridges. We recently worked with an Engineering firm in Florida that resulted in a 400' cable stayed bridge.

Again these are all single spans – if you have a larger Q or the need for a bigger span – multiple spans are an option.

## OPTIONS: STEEL or ALUMINUM PLATE



Deep Corrugated Plate

Aluminum Box Culvert



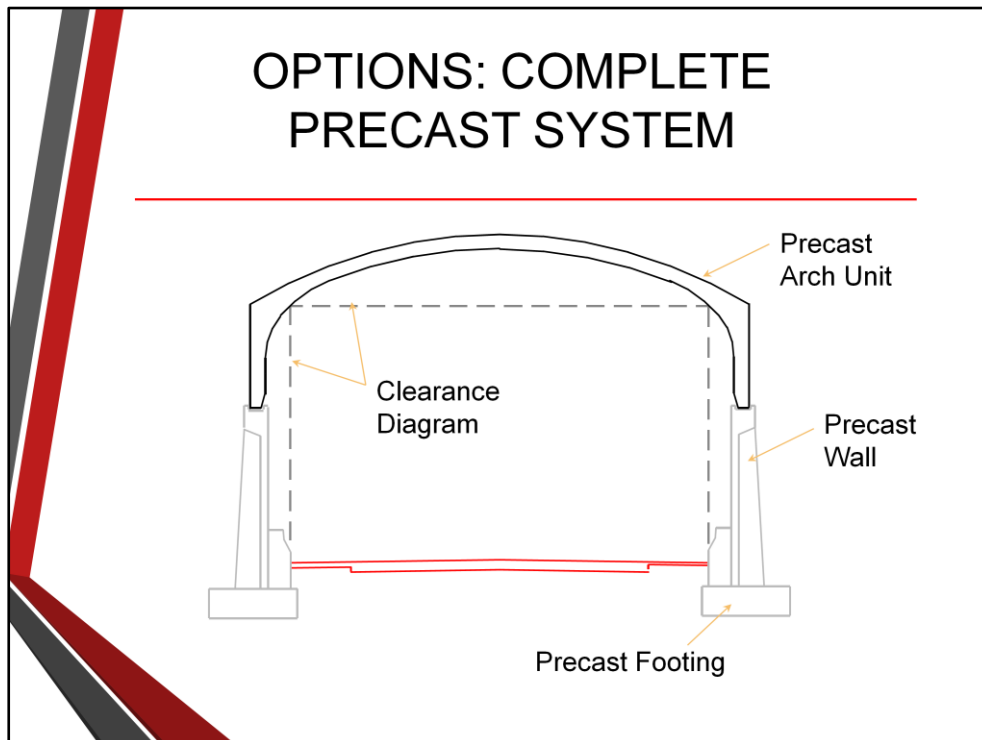
## OPTIONS: PRECAST CONCRETE ARCH



Multiple Barrel  
Culvert

Wildlife  
Overpass





**When increased headroom or height is needed for a structure, our arches may be installed on top of a cast-in-place or precast wall system. The interaction between the arches and the wall is very complimentary and results in an economical wall and foundation design.**

**\*\*** Another example, where you see the pictures of where we take these large clearances through structures and the bottom has been set on a retaining wall, a very good system when you combine that with the arch type. The arch shape is going to kick outward, the foundation system is going to want to rotate inward, the blend of the marriage of the two systems work very well together.

## OPTIONS: PREFAB VEHICULAR AND PEDESTRIAN TRUSS BRIDGE



Archway Vehicular Truss

H-Deck Truss





SPEED OF CONSTRUCTION



# SPEED OF CONSTRUCTION:

## "Pre-engineered Structures"

Table 20. 8000-KS1 Series -

| Span<br>m | Span<br>ft | Clear<br>Span<br>m | Clear<br>Span<br>ft | Weight<br>kg | Weight<br>lb |
|-----------|------------|--------------------|---------------------|--------------|--------------|
| 6.0       | 19.7       | 5.5                | 18.0                | 141          | 310          |
| 6.0       | 19.7       | 5.5                | 18.0                | 141          | 310          |
| 7.0       | 22.9       | 6.5                | 21.3                | 165          | 364          |
| 7.0       | 22.9       | 6.5                | 21.3                | 165          | 364          |
| 8.0       | 26.2       | 7.5                | 24.6                | 190          | 419          |
| 8.0       | 26.2       | 7.5                | 24.6                | 190          | 419          |
| 9.0       | 29.5       | 8.5                | 27.9                | 215          | 474          |
| 9.0       | 29.5       | 8.5                | 27.9                | 215          | 474          |
| 10.0      | 32.8       | 9.5                | 31.2                | 240          | 529          |
| 10.0      | 32.8       | 9.5                | 31.2                | 240          | 529          |
| 11.0      | 36.1       | 10.5               | 34.5                | 265          | 584          |
| 11.0      | 36.1       | 10.5               | 34.5                | 265          | 584          |
| 12.0      | 39.4       | 11.5               | 37.8                | 290          | 639          |
| 12.0      | 39.4       | 11.5               | 37.8                | 290          | 639          |
| 13.0      | 42.7       | 12.5               | 41.1                | 315          | 694          |
| 13.0      | 42.7       | 12.5               | 41.1                | 315          | 694          |
| 14.0      | 46.0       | 13.5               | 44.4                | 340          | 749          |
| 14.0      | 46.0       | 13.5               | 44.4                | 340          | 749          |
| 15.0      | 49.3       | 14.5               | 47.7                | 365          | 804          |
| 15.0      | 49.3       | 14.5               | 47.7                | 365          | 804          |
| 16.0      | 52.6       | 15.5               | 51.0                | 390          | 859          |
| 16.0      | 52.6       | 15.5               | 51.0                | 390          | 859          |
| 17.0      | 55.9       | 16.5               | 54.3                | 415          | 914          |
| 17.0      | 55.9       | 16.5               | 54.3                | 415          | 914          |
| 18.0      | 59.2       | 17.5               | 57.6                | 440          | 969          |
| 18.0      | 59.2       | 17.5               | 57.6                | 440          | 969          |
| 19.0      | 62.5       | 18.5               | 60.9                | 465          | 1024         |
| 19.0      | 62.5       | 18.5               | 60.9                | 465          | 1024         |
| 20.0      | 65.8       | 19.5               | 64.2                | 490          | 1079         |
| 20.0      | 65.8       | 19.5               | 64.2                | 490          | 1079         |
| 21.0      | 69.1       | 20.5               | 67.5                | 515          | 1134         |
| 21.0      | 69.1       | 20.5               | 67.5                | 515          | 1134         |
| 22.0      | 72.4       | 21.5               | 70.8                | 540          | 1189         |
| 22.0      | 72.4       | 21.5               | 70.8                | 540          | 1189         |
| 23.0      | 75.7       | 22.5               | 74.1                | 565          | 1244         |
| 23.0      | 75.7       | 22.5               | 74.1                | 565          | 1244         |
| 24.0      | 79.0       | 23.5               | 77.4                | 590          | 1299         |
| 24.0      | 79.0       | 23.5               | 77.4                | 590          | 1299         |
| 25.0      | 82.3       | 24.5               | 80.7                | 615          | 1354         |
| 25.0      | 82.3       | 24.5               | 80.7                | 615          | 1354         |

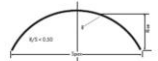
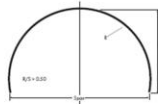


Figure 6. Arch



This structure is to be built with all components are not subject to  
weathering conditions.  
In addition, please refer to Table 20 and 21 and design  
information based on Figure 17-21.  
The following table lists the weight of the structure.

No specialized  
equipment needed;  
assembly can be done  
by road department



## SPEED OF CONSTRUCTION: CONCURRENT FABRICATION (local pre-caster)



## SPEED OF CONSTRUCTION: COMPLETE PRECAST COMPONENTS



- 42 arches
- 12 headwalls
- 4 wingwalls
- 10 nose cones

Installed in 2 days



MODE OF CONSTRUCTION

## MODE OF CONSTRUCTION: BUILD BENEATH (PLATE)



Twin cell 18'-7" x 12'  
Structural Plate Pipe Arch  
with 60 degree skew.

SR 10 Emery County, UT



## MODE OF CONSTRUCTION: BUILD BENEATH (PRECAST)



Telegraph Street  
Washington, UT

24' Concrete Arch on  
8' stem walls with  
27' tall precast wingwalls  
and formliner finish



## MODE OF CONSTRUCTION: PART WIDTH (PLATE)



22' diameter Structural Plate with  
bevel cut ends and natural bottom  
to be used as a deer crossing

US 189 Heber City, UT



## MODE OF CONSTRUCTION: PART WIDTH (PRECAST)



US 95  
ADOT



24' Concrete  
Arch with  
precast slab  
foundation



## State Route 86

### SANTA ROSA PRE-CAST ARCH WILDLIFE UNDERPASS

- Half the underpass was installed in 4 hours on November 26, 2013, as part of an ongoing widening project; the other half will be installed after backfilling and paving, and excavation of the detour site (mid- to late-January 2014).
- Followed construction of a traffic detour, excavation, pouring of footers and foundation.
- Installation was done by Meadow Valley Construction, with assistance from Contech Engineered Solutions and ADOT Tucson Construction.
- The underpass was funded by the Pima County Regional Transportation Authority as part of a grant submitted by the Tohono O'odham Nation.
- The underpass lies within the Kitt Peak Wildlife Linkage, one of the highest priority linkages in the 2006 statewide *Arizona's Wildlife Linkage Assessment*.



## BENEFITS



## BENEFITS: SAVES MONEY

- Reduced Construction Time
- Reduced Road Closure Time
- Reduced # of Spans = Reduced Amount of Material
- No to Low Maintenance
- Long Lasting



Using a precast pedestal wall allowed this large clearance structure to be entirely prefabricated above the foundations. They used precast abutments that had counterforts on the backside, these walls 22 foot tall, 11 foot rise, precast arches were set on top of this structure, and then 10 feet of deadload was placed on top of that.

## BENEFITS: A VARIETY OF SOLUTIONS



- Steel/Aluminum Structures
- Precast Concrete Systems
- Pedestrian and Vehicular Truss Bridges
- MSE Walls
- Scour Protection Mats

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## BENEFITS: INCREASED AESTHETIC VALUE

- Arch Shape
- Custom Designs
- Variety of End Treatments

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## BENEFITS: MANUFACTURE PROVIDED ENGINEERING AND CONSTRUCTION SERVICES



- Hydraulic and Scour Analysis
- Structural Calculations
- Wall and Footing Design
- Stamped Drawings
- Material and Installation Specifications
- On-site Consulting During Installation

Using a precast pedestal wall allowed this large clearance structure to be entirely prefabricated above the foundations. They used precast abutments that had counterforts on the backside, these walls 22 foot tall, 11 foot rise, precast arches were set on top of this structure, and then 10 feet of deadload was placed on top of that.

## INNOVATIVE PREFABRICATED BRIDGES

