CS 198-R-03

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TECH FACTS

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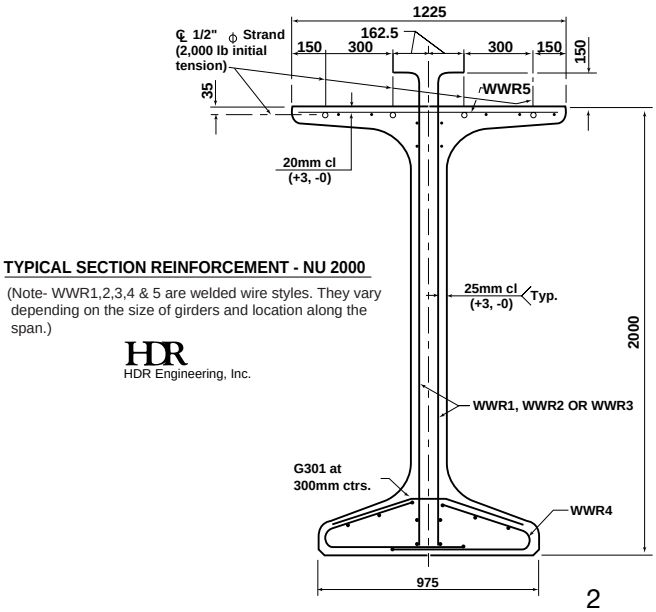
Concrete Bridges With Structural High Strength Welded Wire Reinforcement (WWR)

FROM RESEARCH...

This 150-ft. prestressed concrete "I" girder has over 2 tons of structural high strength (f_y=80,000 psi) welded wire shear reinforcement. These concrete girders were researched and developed by Dr. Maher Tadros and his students at the University of Nebraska. Those girders and others with even longer spans, are being designed into bridges in many states across the country. Research is continuing at the University of Nebraska with epoxy-coated reinforcement. Also Dr. Tadros further advises that he is looking into the cross-sectional area of the horizontal wires providing additional shear strength. The girder shown in these photos is 6-ft.8-in. (2000 mm) high with a top flange 4-ft. (l225 mm) wide.

1

A l5O-ft. bridge "I" girder shown being developed by Dr. Maher Tadros and his students at the University of Nebraska in 1992. This prestressed girder and others like it and some with even longer spans are being designed into bridges in many states across the country.



TYPICAL SECTION REINFORCEMENT - NU 2000

(Note- WWR1,2,3,4 & 5 are welded wire styles. They vary depending on the size of girders and location along the span.)

HDR Engineering, Inc.

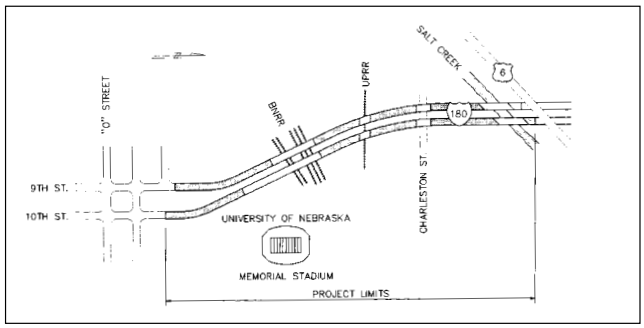
2

TO DESIGN...

The State of Nebraska - Department of Roads - Bridge Division has designed many of these prestressed "I" girder bridges. Consulting engineers in Nebraska and other states have designed bridges using similar precast/ prestressed reinforced concrete girders. Contact your nearest precaster for more details.

ANOTHER DESIGN...

An interstate I-180 section, involved the replacement of 3 structures at 9th and 10th streets. The two longer spans (up to 118', 36m) utilize prestressed girders with welded wire reinforcement. Details are similar to the Nebraska project photos. This interstate section was opened to traffic in 1998.

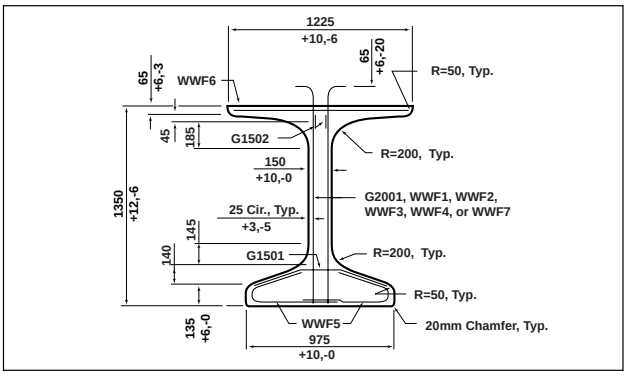


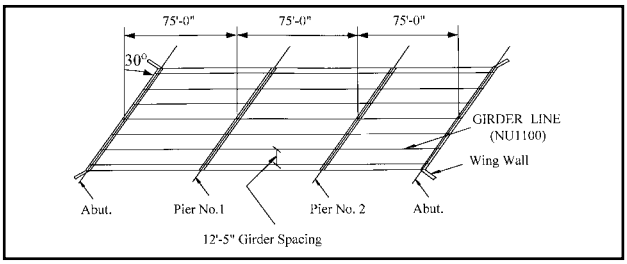
TO CONSTRUCTION...

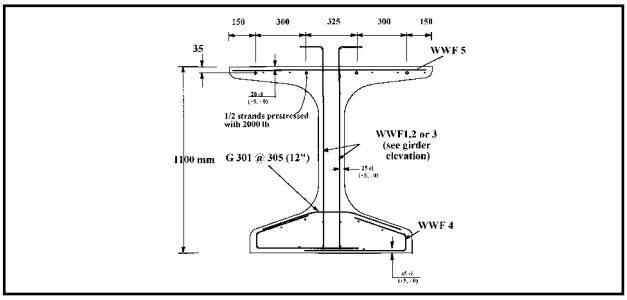
A high performance concrete bridge was constructed at 120th Street and Giles Road in Sarpy County, Nebraska. A plan of the bridge shows it has 3 spans of 75-ft. each.

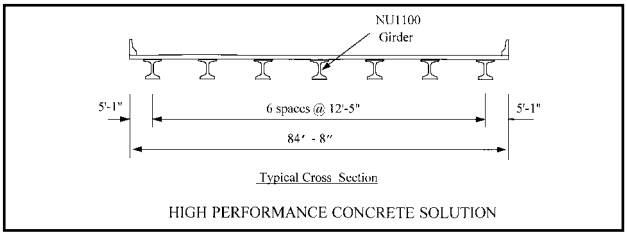
The cross section shows the girder spacing at 12-ft.5-in. Nebraska's bridge type is an NU1100 mm or 43.3 in. deep. The 12-ft.5-in. was used as the maximum spacing even though design trials showed that wider spacing would be more economical. Since the flanges are 4-ft. wide, a 7-l/2in. thick deck could be used. The deck span is about 8-ft.5-in., not the 12-ft.5-in. The cross-section shows that all reinforcement, except the strands and the G301 bottom flange cap bars, is welded wire reinforcement. Incidentally, the cap bars could have been D8.5 deformed high strength wire in place of #3 bars or D15 for #4 bars. This reinforcement mix resulted in nearly a 50% reduction in girder production labor. As an added bonus, WWR provides superior uniformity of wire spacing and concrete cover, it also offers narrow wire spacing at no premium cost to provide better structural performance.

A photo of the completed bridge when it was opened to traffic is shown below. Time saved to place welded wire in forms and time saved to place the finished precast concrete girders is an essential economic consideration in any bridge design.

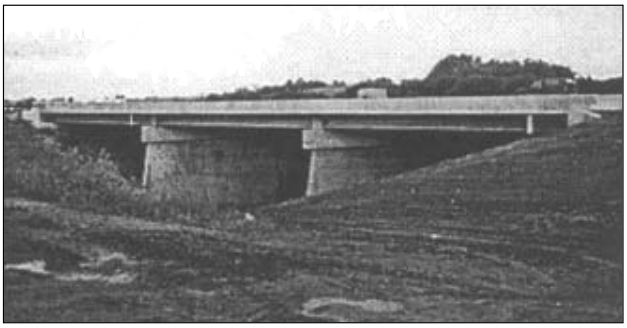








HIGH PERFORMANCE CONCRETE SOLUTION



MORE PROJECTS…

The first metric bridge in the U.S.

According to the University of Nebraska-Lincoln's Center for Infrastructure Research, this Richardson County, Nebraska bridge is the first bridge in the U.S. to have girders in metric units. Instead of the girder dimensions in feet and inches, the girders in the 3 span replacement bridge are being designed and built in hard metric figures. That is the metric numbers are rounded to even whole numbers. The Nebraska Department of Roads (NDOR) has adopted the girder as its new standard for future girder design. The structure is approximately 72 meters (236 feet) in length and 16 meters (52.5 feet) in width. The girder design features extensive use of welded wire for the web shear reinforcement and in the top and bottom flanges. It also provides an excellent base for anchoring post-tensioning tendons. The use of welded wire was a definite innovation for the bridge. The reinforcing provided excellent shear transfer as well the usual crack control and more accurate concrete cover. The "Nebraska University" (NU) girders are not only dimensioned in hard metric, but they are more structurally efficient. The new style girders can span longer lengths than other girders for the same depth and loads, which means that prestressed concrete can be used in situations previously designed only for structural steel. Other states, i.e, Michigan, New England states, Washington state, as well as other countries, i.e, Mexico and Japan have recently introduced various adaptations of the NU standard I-girders.

Bridge Deck Replacement

The State of New York Department of Transportation specified welded wire reinforcement on I-87 bridge deck overlays. Lanes of these bridge decks needed to be removed and replaced in a 48 hour period. Epoxy-coated welded wire provided a low-cost alternative and faster placement compared to bars.

The NY DOT developed a new specification for the rehabilitation of 4 bridge decks totaling 60,000sf of heavily-travelled Interstate 87 near its interchange with the New York Tollway. The NY DOT engineers and contractors said the removal of deck topping and placement of reinforcement and concrete had to be completed to allow for the opening of traffic the next day. Structural High-strength welded wire sheets allowed for faster placement to help meet the construction schedule.

4

A bridge on Highway 8 in Salem, Neb., uses girders that were designed and fabricated in metric. A second metric girder bridge is in the works.

Nebraska Bridge first in U.S. to use metric girders

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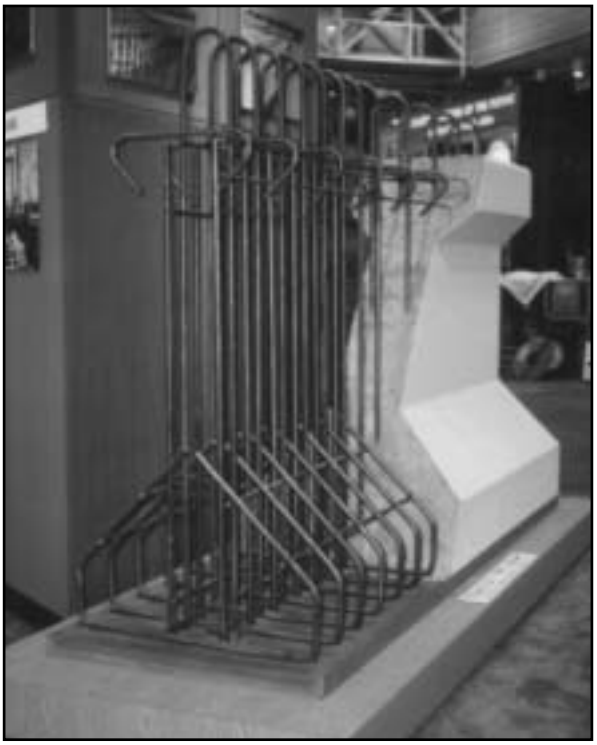
SOME EXAMPLES OF BRIDGE & HIGHWAY COMPONENTS...

AASHTO Standard Beams and Girders

Both AASHTO standard specifications for highway bridges and AASHTO LRFD bridge design specifications approve welded wire reinforcement. For years the many standard cast-in-place or precast/ prestressed components have utilized structural welded wire reinforcement. Consult with WRI members for availability and the ability to furnish reinforcement materials. WRI members can provide the exact area of steel required for those standard highway bridge structures. Some typical AASHTO standard products are:

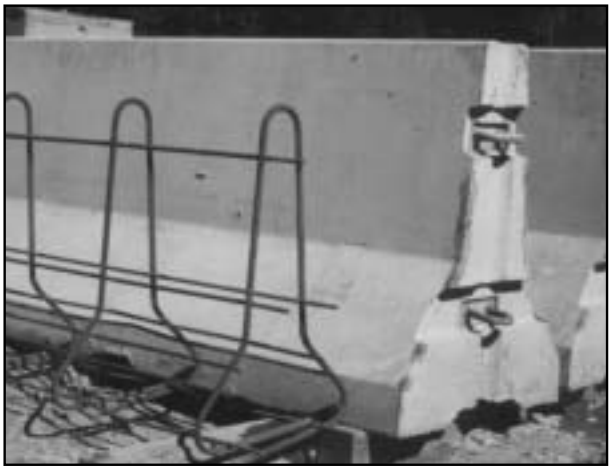
Box Beams
I-Beams
Bulb-Tees
Deck Bulb-Tees
Double Tee Beams
ASBI Standard Segments

Bending welded wire is a simple operation requiring no special skills. Many precasters have the ability to bend all wire sizes produced, from 1/8" to 3/4" diameter. Sheets of welded wire are bent by an arm on the bender that rotates through an angle between 0°-180°, shaping the wires around the mandrels. The arm can be preset to stop at any angle. The mandrels can be varied to meet the design requirements for bend radius and wire spacing. Cutting equipment can be a simple hand tool capable of cutting one wire at a time or larger powered equipment can cut the full width of a sheet in one operation



There are many precast and cast-in-place concrete components for bridges and highways. Welded wire can be epoxy-coated to meet the various DOT's requirements in coastal or snowbelt states. 7

BRIDGE RAIL 7



MEDIAN BARRIERS 7

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SOUND WALLS

Precast concrete soundwalls reinforced with welded wire were the solution for 1.3 million square feet of soundwalls along the Tri-State Tollway through Chicago's western suburbs. The Illinois Tollway Authority is the owner. With an average height of 18 feet, the entire project is 16 lineal miles. The panels are 5" thick with an integral 18 inch - square post ranging in height from six feet to 28 feet. The posts are placed on 30 inch diameter drilled caissons that were poured to an average depth of 13 feet. Prestress Engineering Corp. of Algonquin, Illinois did the precast work. LEAP Associates International Inc., Tampa, Florida engineered the project.

RIGID FRAME ARCH CULVERTS

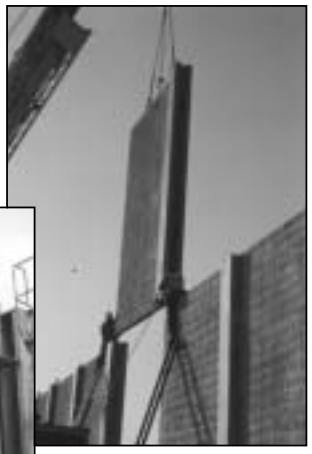
SIZE:
The culvert spans 36'-0" and rises 8'-6" above the stream bed. The total length of the culvert between spandrel walls is 52'-0".

PRECAST UNITS:
The culvert is comprised of ten (10) free standing segmental units, each 5'-2" in width, for a total of 52'-0". Each segment's rigid frame consists of vertical legs 7'-9" high and 1'-2" thick, with a 1' - thick arch rib which has a 40'-0" radius. The culvert section has a rise of 11'-0". These segments are a patented system by Con/Span, Inc.

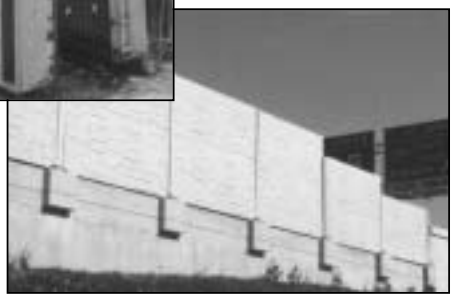
All segments were fabricated with a minimum of 5000 p.s.i. concrete and reinforced with epoxy-coated welded wire reinforcement (min f_y = 65,000 psi) with 2 x 8 grids. Sheets of reinforcing were placed in layers to achieve the required areas of reinforcement.

COMPLETION & COST:
As part of a three stage project, the culvert was opened to traffic in December 1993. The project also included stream channel relocation, construction of a precast concrete box culvert, roadway realignment and landscaping of the project area.

The road this culvert serves is the only access to an urban airport and four industrial businesses. This required that both the route and all utilities be kept in operation at all times. This could only be accomplished by using a system of free standing structural units. The total project was completed in 400 days at a cost of $1.04 million.



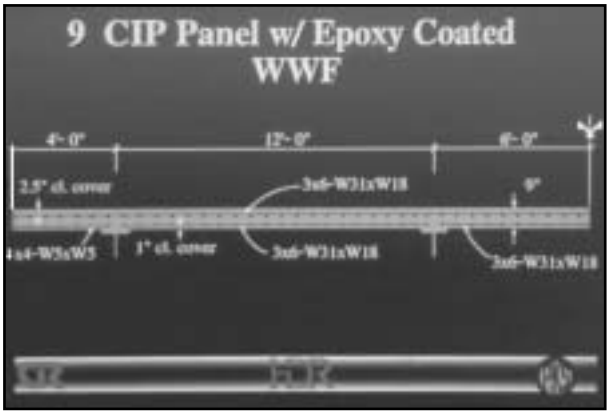
8,9,10

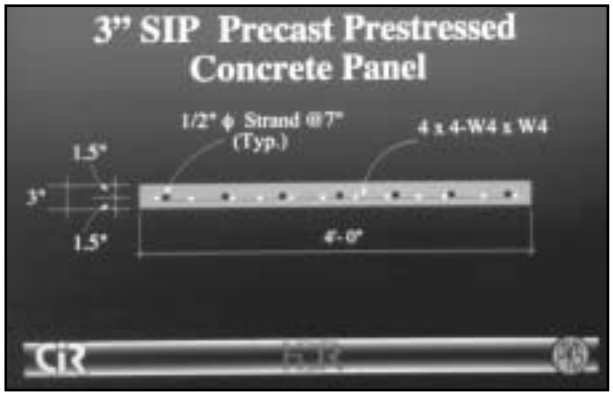


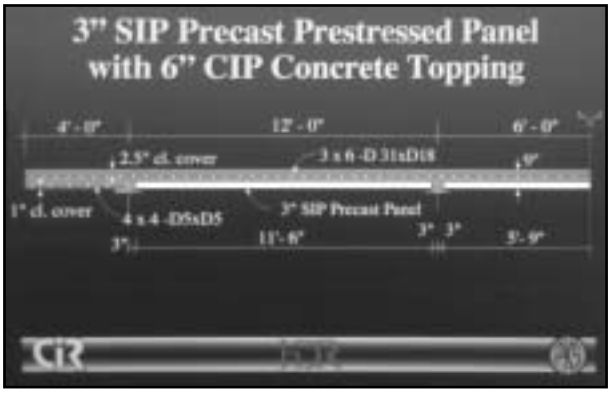
11, 12, 13, 14

SOME RECENT RESEARCH

The University of Nebraska has recently completed it's research and testing on both cast-in-place bridge decks and precast bridge deck panels. The report for rapid deck replacements has been submitted to the Federal Highway Administration. FHWA is very happy with the research. Testing included large epoxy-coated wires (up to D31, 5/8" in diameter) in these welded wire examples. Also fatigue testing to AASHTO specifications was included and demonstrated excellent results.







REMEMBER - When you design and construct cast-in-place or precast/prestressed bridge girders and bridge components utilizing the inherent high-strength characteristics of structural welded wire reinforcement, there can be substantial material and placing cost savings. As a bonus you get superior quality control of material and construction tolerances.

Credits for the photos and by-lines are:

1. The University of Nebraska
2. HDR Engineering, Inc., Omaha, NE
3. Harrington & Cortelyou Inc., Consulting Engineers, Kansas City. MO
4. The State of Nebraska-Department of Roads - Bridge Division
5. The State of New York, Department of Transportation
6. Harrison & Burrowes Bridge constructors, Glenmont, NY
7. Exhibit models by a WRI Producing Member
8. The Illinois Tollway Authority
9. Prestress Engineering Corp., Algonquin, IL
10. LEAP Associates International Inc., Tampa, FL
11. Con/Span/Bridge Tech, Dayton, OH
12. Philadelphia Dept. of Streets/GC - A.P. Construction, Philadelphia, PA
13. Superior Precast Inc.
14. Precast/Prestressed Concrete Institute