Precast Bridge Deck Solutions For Rapid Rehabilitation Of A Truss Bridge.

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Figure 1-View of bridge.

ABSTRACT:

The Bridge and Structures Office completed the design for the Lewis and Clark Bridge deck replacement project in October of 2002. This historic bridge, designed by Joseph B. Strauss of Golden Gate Bridge fame, was built in 1930. It spans the Columbia River between Longview, Washington and Rainier, Oregon. The bridge consists of a 2,720-foot long main through-truss section, a 927-foot long deck truss section on the Oregon side, and a 168-foot long deck truss and a 1,507 foot long 12 span rolled-beam section on the Washington side. The bridge could only be closed to traffic at night from 9:30 P.M. to 5:30 A.M. during construction due to traffic constraints. Night closures were limited to 120 days and single-lane closures were limited to 200 days. The WSDOT Bridge Office designed a method to replace the existing concrete deck on the main through-truss and deck trusses, and for widening the existing deck on the rolled beam spans, using precast concrete deck panels. A total of 103 precast panels with a constant width of 36 feet and variable lengths of 25 to 45 feet were placed on the trusses. For the rolled-beam spans 46 precast panels with a constant width of 4 feet and variable lengths of 58 to 70 feet were placed. Construction is complete as of this date. This paper will examine in depth the design, construction and lifting operations involved with the replacement of the existing bridge deck with precast full width panels. Total cost of this project was $27 million.

KEYWORDS: Precast deck panels, Lightweight concrete, Floor beam, Steel girders, Rolled beams, Trusses, Self propelled modular trailers, Washington State Department Of Transportation.

History and Condition Of Bridge:

The existing Lewis and Clark Bridge was constructed by the private Longview Bridge Company and opened to traffic as a toll bridge in 1930. This historic bridge spanning the Columbia River between Longview, Washington and Rainer, Oregon was designed by Joseph A. Strauss of Golden Gate Bridge fame. The Washington State Toll Bridge Authority purchased the bridge in 1947 and the Washington State Department of Transportation (WSDOT) took over maintenance functions in 1948. Tolls were removed in 1965. The bridge consists of a 2,720-foot long main through truss section, a 927-foot long deck truss section on the Oregon side, and a 168-foot long deck truss and a 1,507-foot long 12 span rolled beam section on the Washington side. See Figure 2 for details.

A 30-year preservation plan completed in 1991 by WSDOT detailed nearly $30 million in work to keep the bridge structurally sound. The overall condition of the bridge was characterized as fair to poor. The most immediate needs were the deck replacement on the through and deck trusses, and for widening the existing deck on the Washington approaches and a portion of the Oregon approach. Seismic retrofit of the existing expansion bearings, painting and other remedial work on both approaches constitute a majority of the other work that was recommended. The existing floor beams were in fair condition with many of them having a section loss of 5 % to 25% on the top flanges. It was decided that the floor beams except from being cleaned and painted did not require rehabilitation, provided a stress reduction could be achieved with a new deck system. State and local governments agreed that rehabilitating the bridge was more practical and financially feasible as opposed to building a new bridge.

Both WSDOT and the Oregon Department Of Transportation (ODOT) met with the local business community and the general public to get input on traffic control restrictions for the project. Based on this feedback, the project was set up to close the bridge to vehicular traffic to accommodate the through and deck truss deck panel removal and replacement for 8 hours at night from 9.30 P.M. to 5.30 A.M. A total of 103 precast deck panels with a constant width of 36 feet and variable lengths of 25 to 45 feet were required to be placed on the trusses. For the widening of the Washington approach and a span of the Oregon approach 48 precast deck panels with a constant width of 4 feet and variable lengths of 58 to 70 feet were required. The widening of the approaches was accomplished using single lane closures. To perform the overall work the Contractor was limited to 120 days of 8-hour night closures and 200 days of single lane closures. For placement of the first deck panel the Contractor was allowed a weekend closure to test both equipment and procedure for the replacement of the full-width deck panels. In addition, the Contractor was allowed two weekend closures to place a concrete overlay on the approaches and complete a bearing retrofit.

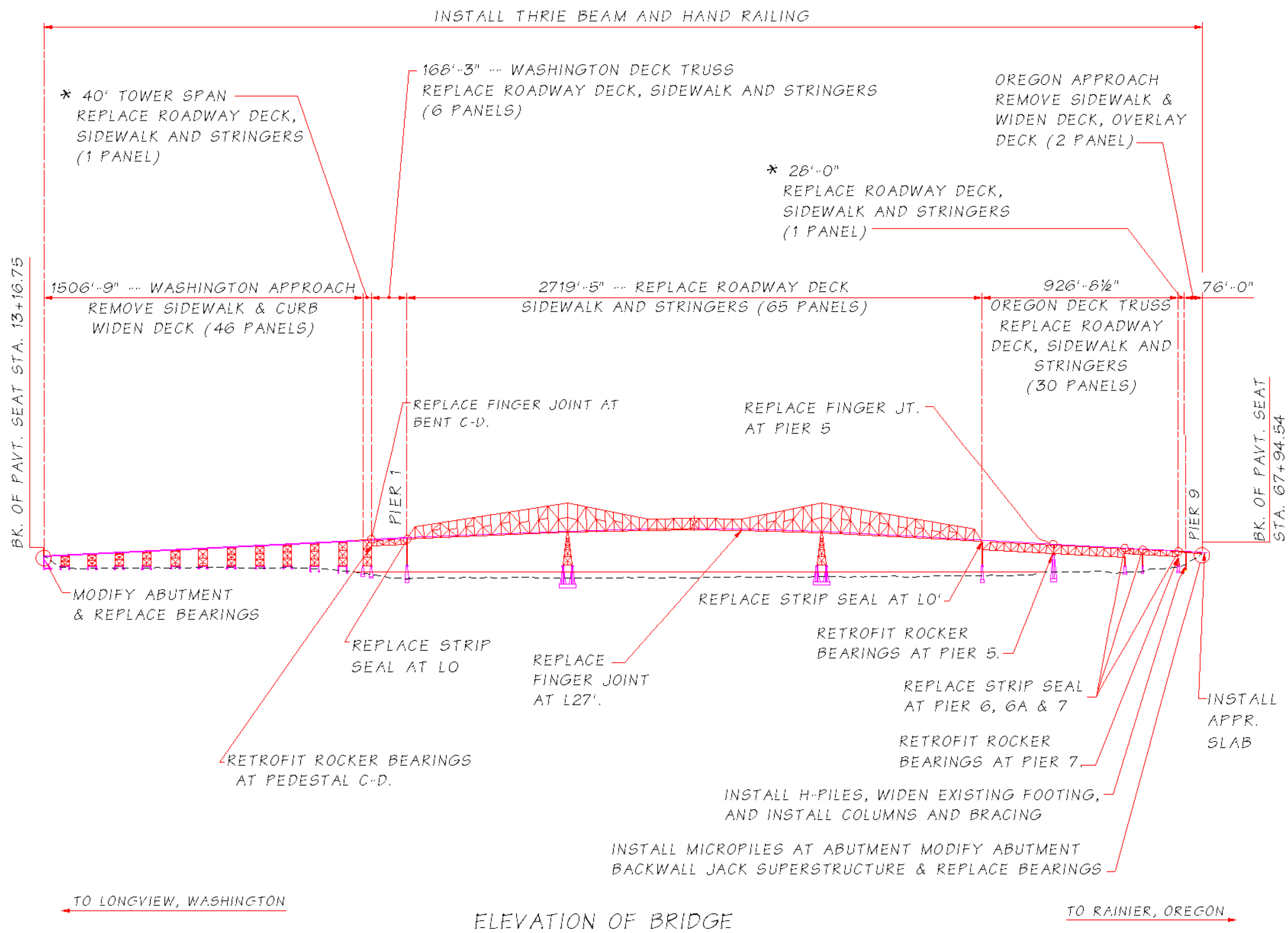
INSTALL THRIE BEAM AND HAND RAILING
* 40' TOWER SPAN REPLACE ROADWAY DECK, SIDEWALK AND STRINGERS (1 PANEL)
168'-3" --- WASHINGTON DECK TRUSS REPLACE ROADWAY DECK, SIDEWALK AND STRINGERS (6 PANELS)
OREGON APPROACH REMOVE SIDEWALK & WIDEN DECK, OVERLAY DECK (2 PANEL)
* 28'-0" REPLACE ROADWAY DECK, SIDEWALK AND STRINGERS (1 PANEL)
BK. OF PAVT. SEAT STA. 13+16.75
1506'-9" --- WASHINGTON APPROACH REMOVE SIDEWALK & CURB WIDEN DECK (46 PANELS)
2719'-5" --- REPLACE ROADWAY DECK SIDEWALK AND STRINGERS (65 PANELS)
926'-8½" OREGON DECK TRUSS REPLACE ROADWAY DECK, SIDEWALK AND STRINGERS (30 PANELS)
76'-0"
BK. OF PAVT. SEAT STA. 67+94.54
REPLACE FINGER JOINT AT BENT C-D.
REPLACE FINGER JT. AT PIER 5
PIER 1
PIER 9
MODIFY ABUTMENT & REPLACE BEARINGS
REPLACE STRIP SEAL AT L0'
REPLACE STRIP SEAL AT L0
REPLACE FINGER JOINT AT L27'.
RETROFIT ROCKER BEARINGS AT PIER 5.
REPLACE STRIP SEAL AT PIER 6, 6A & 7
INSTALL APPR. SLAB
RETROFIT ROCKER BEARINGS AT PEDESTAL C-D.
RETROFIT ROCKER BEARINGS AT PIER 7.
INSTALL H-PILES, WIDEN EXISTING FOOTING, AND INSTALL COLUMNS AND BRACING
INSTALL MICROPILES AT ABUTMENT MODIFY ABUTMENT BACKWALL JACK SUPERSTRUCTURE & REPLACE BEARINGS
TO LONGVIEW, WASHINGTON
TO RAINIER, OREGON
ELEVATION OF BRIDGE

Figure-2

Design and Construction Methodology:

A) Full width deck panels

The existing lightweight deck in the through and deck truss sections had a unit weight of 120 pcf and was supported by six stringers spanning between floor beams as shown in Figure 3. Because of the section loss suffered by the floor beam flanges, and the desire to retain these steel members in the rehabilitated structure, it was decided to reduce the dead load stresses in these floor beams as much as possible. This, coupled with an allowable construction window of only 8 hours necessitated the use of a twin longitudinal girder system spanning between the, existing floor beams. The longitudinal girders, in turn, were connected by a series of intermediate transverse stringers as shown in Figure 4. This precast deck panel system not only reduced the dead load stresses on the floor beams by 40 percent, but also reduced the number of connections to the floor beam from six to two, thereby saving valuable installation time. The weight of new deck panels was only about 5 percent lower than the removed deck section. The precast full-width deck panel was designed to sit on preinstalled beam seats. The seats consisted of two channels C 15x33.9 attached to the floor beam and a wide flange W16x100 attached to the channels as shown in Figure 5. Though the Plans called for shop drilling the holes in the beam seat for attachment to the longitudinal girders, the contractor proposed, and received approval, to field drill the holes in the beam seats for better fit of the deck panel. After installation of the panel, the longitudinal beams were attached to the existing floor beam stiffeners by plates as shown on Figure 5. Minor variations of the beam seat were used at the finger joint locations and on the Oregon and Washington approaches. The replacement lightweight precast deck panels had a preinstalled 1-inch thick latex modified concrete overlay to provide long-term durability for the deck. For the most part the Contractor did not have any problems installing the deck panels in the 8-hour closure period. Table 1 below shows the concrete mix proportions for the lightweight concrete deck!

Material	**Quantity (per cyd)**
Portland Cement	600 lb.
Fly Ash	80 lb.
Fine Aggregate	1158 lb.
Coarse Aggregate	1114 lb.
Total Water	270 lb.
Air Entrainment (Daravair)	3.2 oz.
Water Reducer (WRDA 64)	34 oz.
H_20/Cement Ratio	0.40
Slump	4 +/- 1”
Unit weight	119 pcf

Table 1

B) Partial width deck panel

To match the new roadway cross-section on the trusses the approaches with the rolled beam spans were widened on both sides of the roadway deck with precast slab sections. These sections were placed directly on the widened crossbeams using single lane closures. See Figure 6 for details of the precast sections. To smooth the transition between old and new deck a 1- ½ inch rapid set latex modified concrete overlay was placed during a weekend closure.

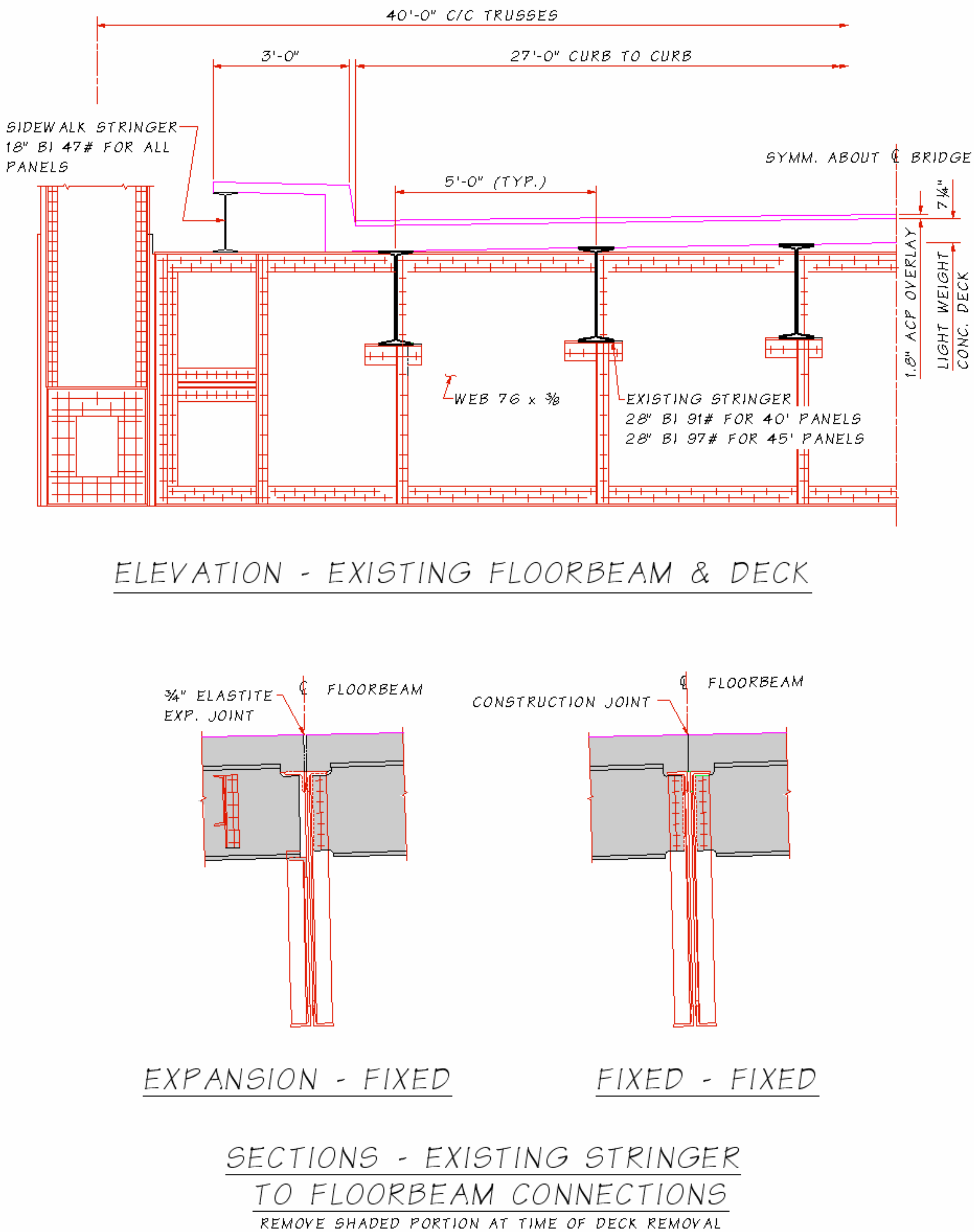
40'-0" C/C TRUSSES
3'-0"
27'-0" CURB TO CURB
SIDEWALK STRINGER
18" BI 47# FOR ALL PANELS
SYMM. ABOUT ℄ BRIDGE
5'-0" (TYP.)
7 ¼"
1.8" ACP OVERLAY
LIGHT WEIGHT CONC. DECK
WEB 76 x ⅜
EXISTING STRINGER
28" BI 91# FOR 40' PANELS
28" BI 97# FOR 45' PANELS
ELEVATION - EXISTING FLOORBEAM & DECK
¾" ELASTITE EXP. JOINT
℄ FLOORBEAM
CONSTRUCTION JOINT
℄ FLOORBEAM
EXPANSION - FIXED
FIXED - FIXED
SECTIONS - EXISTING STRINGER TO FLOORBEAM CONNECTIONS
REMOVE SHADED PORTION AT TIME OF DECK REMOVAL

Figure 3

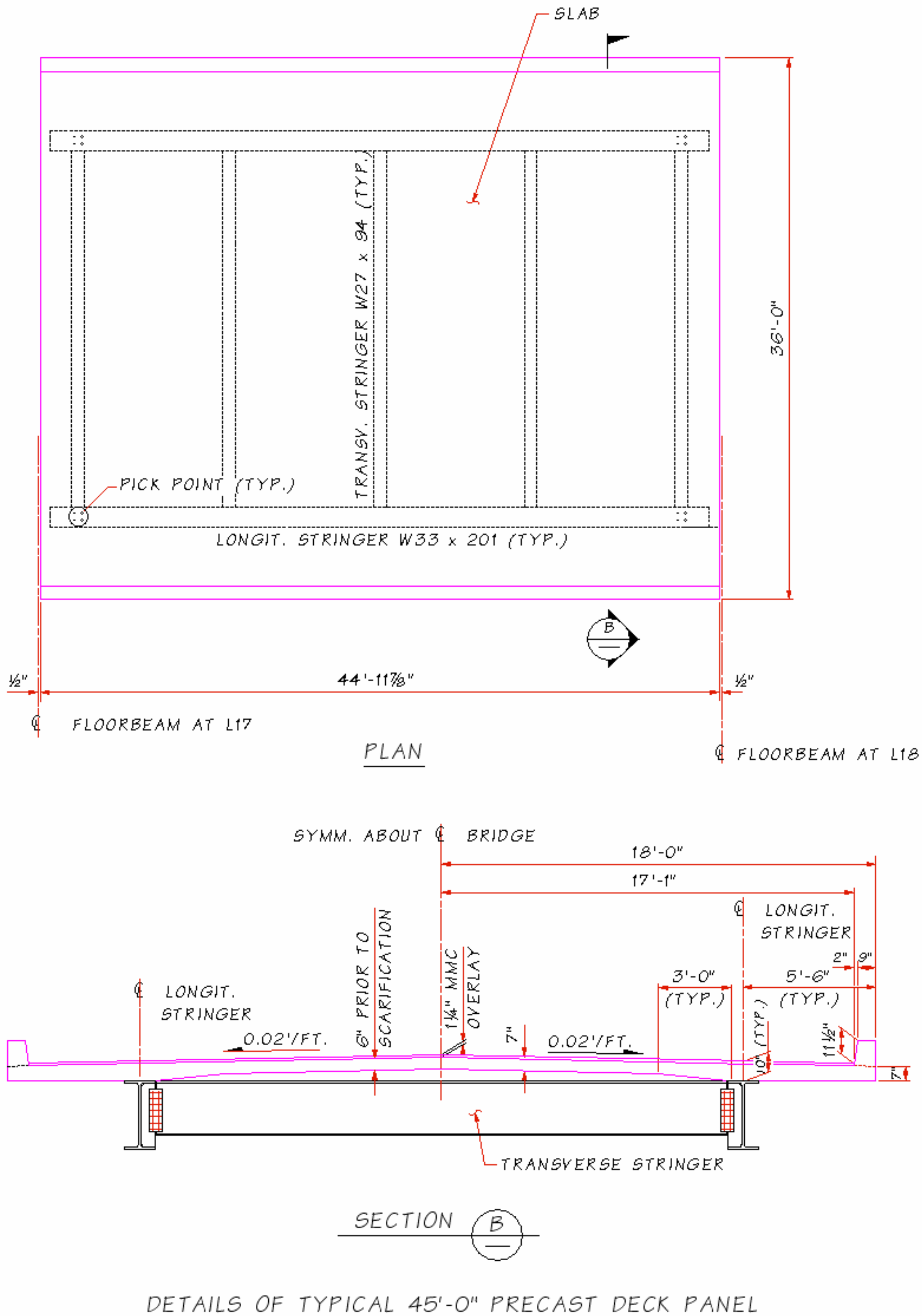
SLAB
TRANSV. STRINGER W27 x 94 (TYP.)
36'-0"
PICK POINT (TYP.)
LONGIT. STRINGER W33 x 201 (TYP.)
B
½"
44'-11⅞"
½"
℄ FLOORBEAM AT L17
PLAN
℄ FLOORBEAM AT L18
SYMM. ABOUT ℄ BRIDGE
18'-0"
17'-1"
℄ LONGIT. STRINGER
2"
9"
3'-0" (TYP.)
5'-6" (TYP.)
℄ LONGIT. STRINGER
6" PRIOR TO SCARIFICATION
1¼" MMC OVERLAY
7"
0.02'/FT.
0.02'/FT.
10" (TYP.)
11½"
7"
TRANSVERSE STRINGER
SECTION B
DETAILS OF TYPICAL 45'-0" PRECAST DECK PANEL

Figure 4

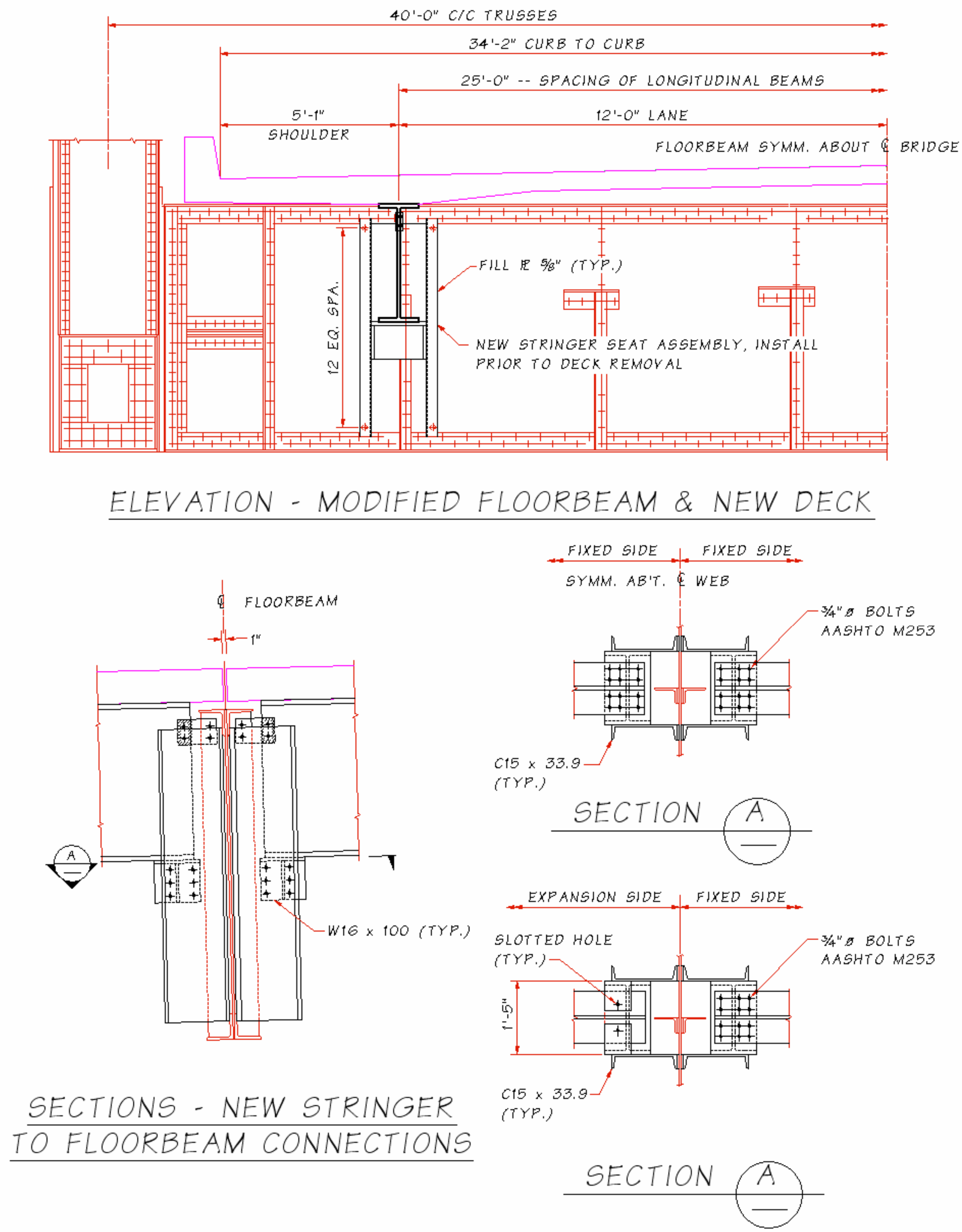
40'-0" C/C TRUSSES
34'-2" CURB TO CURB
25'-0" -- SPACING OF LONGITUDINAL BEAMS
5'-1"
SHOULDER
12'-0" LANE
FLOORBEAM SYMM. ABOUT ℄ BRIDGE
12 EQ. SPA.
FILL ℞ 5/8" (TYP.)
NEW STRINGER SEAT ASSEMBLY, INSTALL
PRIOR TO DECK REMOVAL
ELEVATION - MODIFIED FLOORBEAM & NEW DECK
FIXED SIDE
FIXED SIDE
SYMM. AB'T. ℄ WEB
¾"ø BOLTS
AASHTO M253
C15 x 33.9
(TYP.)
SECTION A
℄ FLOORBEAM
1"
A
W16 x 100 (TYP.)
EXPANSION SIDE
FIXED SIDE
SLOTTED HOLE
(TYP.)
¾"ø BOLTS
AASHTO M253
1'-5"
C15 x 33.9
(TYP.)
SECTIONS - NEW STRINGER
TO FLOORBEAM CONNECTIONS
SECTION A

Figure 5

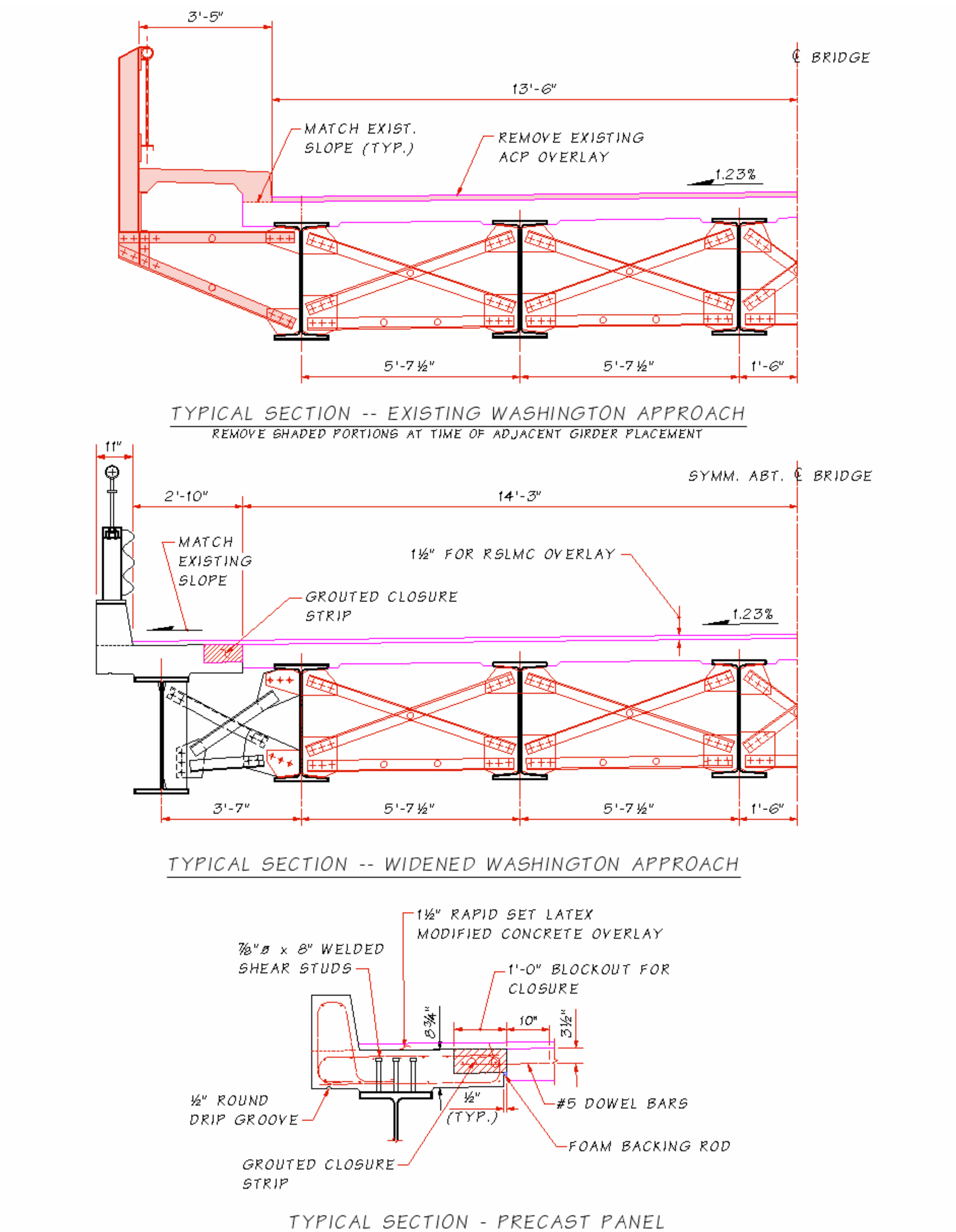
3'-5"
℄ BRIDGE
13'-6"
MATCH EXIST. SLOPE (TYP.)
REMOVE EXISTING ACP OVERLAY
1.23%
5'-7 ½"
5'-7 ½"
1'-6"
TYPICAL SECTION -- EXISTING WASHINGTON APPROACH
REMOVE SHADED PORTIONS AT TIME OF ADJACENT GIRDER PLACEMENT
11"
SYMM. ABT. ℄ BRIDGE
2'-10"
14'-3"
MATCH EXISTING SLOPE
1½" FOR RSLMC OVERLAY
GROUTED CLOSURE STRIP
1.23%
3'-7"
5'-7 ½"
5'-7 ½"
1'-6"
TYPICAL SECTION -- WIDENED WASHINGTON APPROACH
1½" RAPID SET LATEX MODIFIED CONCRETE OVERLAY
⅞"ø x 8" WELDED SHEAR STUDS
1'-0" BLOCKOUT FOR CLOSURE
8¾"
10"
3½"
½" ROUND DRIP GROOVE
½" (TYP.)
#5 DOWEL BARS
FOAM BACKING ROD
GROUTED CLOSURE STRIP
TYPICAL SECTION - PRECAST PANEL

Figure 6

Lifting Operations: The contract plans had an Engineer's suggested method for replacement of the deck panels for both the through-truss and deck trusses. For the through-truss, it consisted of a crane rail system attached to it. For the deck trusses, a special lifting frame with a crane rail system attached to it was designed. The contactor proposed an alternate system, which utilized a single system for replacement of the deck panels in both the deck and through-trusses. The contractor's method was found to be acceptable after careful review of the proposal, which included a detailed analysis of the existing structure for the heavy construction loads.
The lifting operations associated with the replacement of the deck panels was designed and executed by the subcontractor MAMMOET USA, INC; Rosharon, Texas. The lifting system consisted of two self-propelled modular trailers with a specially designed lifting truss spanning the trailers. Air hoists were used to remove the old deck panel and lower the new pre-cast deck panel into place. Figure 7 shows the trailers and the lifting truss and the sequence of operations involved in removing and replacing the deck panel. Table 2 below shows the break down of the lifting loads. Figure 8 illustrates a fully constructed deck panel being readied for transportation to the site.

Component	**Load (kips)**
Lifting Truss	108
Self Propelled Modular Trailers	212
Old Deck Panel	192
New Deck Panel	184
Hydraulic Equipment Hoists And Miscellaneous.	4
Total	**700**

Table 2

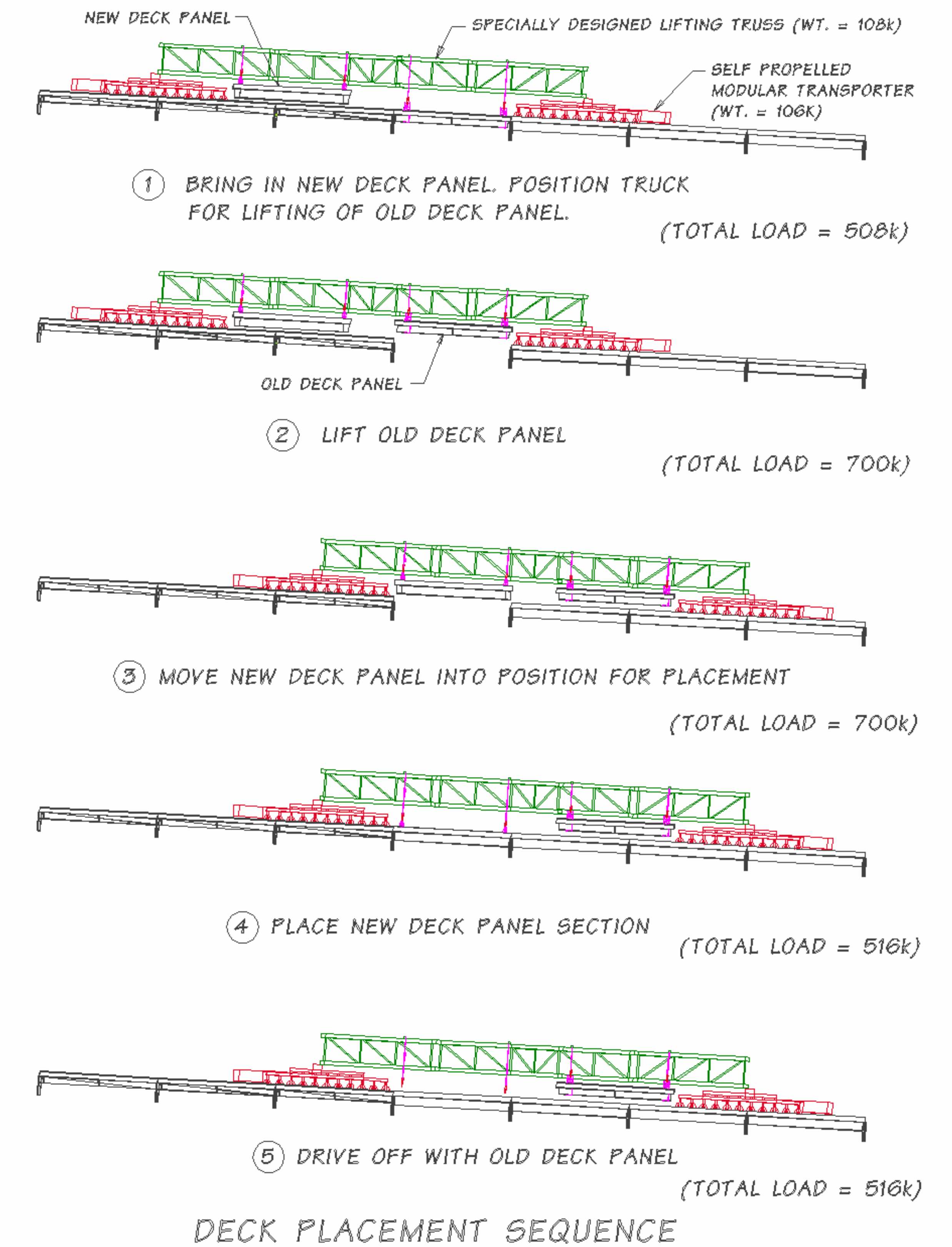
NEW DECK PANEL
SPECIALLY DESIGNED LIFTING TRUSS (WT. = 108k)
SELF PROPELLED MODULAR TRANSPORTER (WT. = 106K)
1 BRING IN NEW DECK PANEL. POSITION TRUCK FOR LIFTING OF OLD DECK PANEL.
(TOTAL LOAD = 508k)
OLD DECK PANEL
2 LIFT OLD DECK PANEL
(TOTAL LOAD = 700k)
3 MOVE NEW DECK PANEL INTO POSITION FOR PLACEMENT
(TOTAL LOAD = 700k)
4 PLACE NEW DECK PANEL SECTION
(TOTAL LOAD = 516k)
5 DRIVE OFF WITH OLD DECK PANEL
(TOTAL LOAD = 516k)
DECK PLACEMENT SEQUENCE

Figure 7

Figure 8

<u>Conclusions</u>: The precast concrete deck panel system showed that rapid replacement of the deck in truss bridges and widening of the deck in the rolled beam spans is possible, without closing down the bridge for more than 8 hours at night. The impact to the businesses community and the general public was minimal when considering the magnitude of the project. It may be appropriate to use this concept for rehabilitation of other truss bridges subjected to similar traffic and time constraints. The bridge deck will be monitored to gauge its durability. Total cost for the project was $27 million.

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