EA: 04-0120R4

Temporary Bypass Structure, SFOBB East Span Seismic Safety Project
East Tie-In Design Criteria

No.	Comment Date	Section number	Title	ETI Design Criteria COMMENTS	Response Date	Status	*Response by Oversight Engineer to Reviewer's comment, if required.	Verify
East Tie-In Design Criteria, comments by Structure Construction								
		10		The last paragraph of Section 10 prior to Section 10.1 makes mention of Figure 4.7.1b. Where is this figure located?				
		11		Please expand more upon the procedures by which sensitivity studies will be conducted. What is meant by using variation of 25% of predicted jacking values.				
		11.2		What points along the bridge will be surveyed to determine the baseline condition before jacking, load transfer and lowering takes place?				
		11.2/11.5		As it is expected that there will be displacement of the bridge while jacking, load transfer and lowering, has the regrading of Span YB4 already taken into account the final resting position of the bridge after the load transfer has taken place?				
		11.3		As discussed during 10-15-04 meeting, please provide provisions for how the North Truss will be monitored for displacement during the load transfer process of the South Truss.				
		11.5		As re-grading will be necessary to conform with the ETI, what type of material (AC or Polyester Concrete) will be applied as overlay. Will grinding be also necessary to facilitate with conform?				
		11.5		Since re-grading of the existing portion of Span YB4 will be necessary to conform with the ETI contour grades, the staging of this process needs to be expanded upon more clearly in the criteria.				
		11.7		Please explain what is meant by "lightly jacking"				
		11.7		Before the bridge removal of the northern portion of Span YB4, how will it be determined that nearly zero loading has taken place on the North Truss? A process should be called out before proceeding with Stage 8.				
		11.7/11.8		Stage 7 shows new stringers to be provided to augment the post/brace system, but this detail has been revised as called out in the ETI Information Drawings. Please revise accordingly.				
		11.9		In the final process of adjusting the elevation of the bridge, the displacement monitoring and control should be addressed also.				

PROPOSED CHANGES TO THE DESIGN CRITERIA NO. 1 THRU NO. 10 SHEETS

FOR THE TEMPORARY BYPASS STRUCTURE – EAST TIE-IN (ETI)

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NOVEMBER 22, 2004

UNLESS OTHERWISE NOTED, THE TBS – ETI SHALL BE DESIGNED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS

1. GENERAL

1.1 Definition of Terms:

Temporary Bypass Structure (TBS)
The Temporary Bypass Structure (TBS) is the West Tie-In, Viaduct and East Tie-In segments

Temporary Structures
Temporary Structures are those used to build the TBS, or remove portions of existing bridge structure to facilitate TBS construction. Temporary Structures are classified as Ordinary or Important.

Ordinary Construction

Falsework
Shoring
Bridge Removal Location A – Falsework and Bracing

Important Construction (for operations of High Consequence)

Load Transfer from the existing YB4 truss to the new East Tie-In structural steel frame and removal of the South Truss of Span YB4 including jacking system installation and support locks if used.

Placement of the North Support System and Removal of the North Truss and portions of Existing Floor Beams.

Temporary Shoring – Excavation bracing adjacent to the foundations for the Existing YBI Viaduct and East Tie-In. Shoring shall be either Braced or Restrained with Tie-Back's.

2. DESIGN LOADS

2.3.6 Live Load- East Tie-In

Live loads shall be applied to each stage carrying traffic. The East Tie-in needs to be designed for the full live load (all 5 lanes top and bottom) during all stages. Any reduction in the applied force can only be evaluated if the time duration and loading of each stage is clearly defined.
ww

2.5 Wind – W

On Finished ETI: in accordance with Caltrans BDS

On Structures during construction: in accordance with SEI/ASCE 37-02 with companion ANSI/ASCE 7-95 and Caltrans BDS.

3. MATERIALS

3.3 Structural Steel for ETI

3.3.2 Fasteners

ASTMA325, high strength bolts with approved corrosion mitigation or A490, high strength bolts approved corrosion mitigation unless noted otherwise (pending CCO).

3.3.5 Fatigue

Components shall be checked per BDS to withstand fatigue induced by 500,000 cycles of loading.

All existing members of the YB4 span which are to be incorporated into the ETI shall be evaluated for their fatigue resistance to 2,000,000 cycles of loading in their projected Lifetime taking into account their total history of loading.

4. SEISMIC DESIGN

4.2 Segments and Articulation

The Temporary Bypass Structure shall consist of three distinct structures:

i) The West Tie-In
ii) The Viaduct
iii) The East Tie-In

The distinct structures shall be separated by expansion joints located at the beginning of Viaduct (Sta. 51+23 top deck, Sta. 51+33 bottom deck) and at the Viaduct span 52 hinge In support (Sta. 54+61).

East Tie-In

The East Tie-In may be a two-span continuous double-deck structure anchored to Pier E-1. The anchorage shall be designed to resist forces resulted from overstrength of a ductile fusing mechanism with a safety factor of not less than 3 The anchorage shall be designed to resist the total design seismic force of the East Tie-In span only.

4.2.4 Dynamic Characteristics - East Tie-In

The articulation of the East Tie-In is defined in Figure 4.2.

The ETI structure shall be tied to Pier E-1 and be allowed to move along with Pier E-1 in the longitudinal direction. At Pier E1 the superstructure shall be capacity-protected against forces associated with the load limiting devices attached to Pier E-1. The anchorage shall be designed to resist forces resulted from overstrength of a ductile fusing mechanism with a safety factor of not less than 3 (3xDEE).

For structural modeling purposes Pier E1 is assumed to move 50mm for the D_{EE} event and 150 mm at D_{LS}.

The Superstructure shall be attached to Pier E1 with approved load limiting devices. The load limiting devices shall be designed to protect the superstructure against maximum seismic forces developed.

At intermediate support to ETI structure, the superstructure shall have capacity protection against the maximum forces (longitudinal and transverse) to develop in the substructure. .

4.3 Performance Criteria

4.3.7 Collapse Avoidance

For seismic loading during construction, the performance objective shall be to avoid collapse. See Sections 4.12 and sections 8,9, & 11 for performance objectives involved with High Consequence Operations.

9. TEMPORARY STABLIZATION FOR SPANS YB4 & YB3

9.1 General

Existing YBI Span YB3 (Pier YB3 – Pier YB4) and Span YB4 (Pier YB4 – Pier E1) shall be stabilized prior to release of any existing anchorage or jacking of Span YB4.

All connections to existing steel truss members shall be bolted. For connection design to existing truss, use allowable tensile stress of 140 MPa (20 ksi).

9.2 Anchorage of Span YB4 at Pier E1

Minimum temporary anchorage for span YB4 at Pier E1 prior to releasing existing anchorage (cut through shoe) shall be:

i) 2400 kN at each bottom chord of N. & S. truss in the transverse direction
ii) 2400 kN in each bottom chord of N. & S. truss in the longitudinal direction.

9.3 Anchorage of Span YB4 at Pier YB4

Minimum temporary anchorage for span YB4 at Pier YB4 prior to releasing existing anchorage (cut through shoe) shall be:

i) 2400 kN at each bottom chord of N. & S. truss in the transverse direction
ii) 2400 kN in each bottom chord of N. & S. truss in the longitudinal direction.

9.4 Restraint of Span YB3 at Piers YB3 & YB4

Minimum temporary restraint for span YB3, prior to releasing existing anchorage of Span YB4 and until complete removal of the span, shall be:

i) at Pier YB4, 2400 kN at each bottom chord of N. & S. truss in the transverse direction
ii) at Pier YB3, 2400 kN tie across each bottom chord of N. & S. truss between Spans YB2 and YB3, in the longitudinal direction.

REPLACE SECTIONS 10 AND 11 WITH THE FOLLOWING:

10. INCORPORATING THE EXISTING YB4 SPAN INTO THE EAST TIE-IN DESIGN

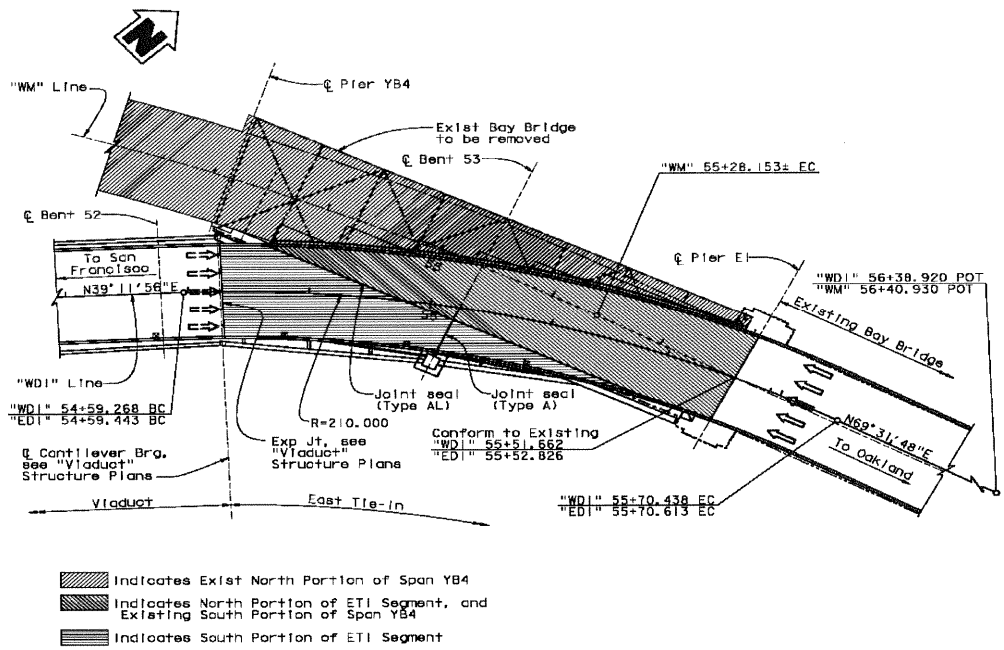


Figure 10.1: Plan View of the East Tie-In

The East Tie-In structure as shown in Figure 10.1 includes:

a) South Portions of East Tie-In
b) North Portions of East Tie-In (South Portion of existing South YB4 to remain)
c) North Portions of Existing YB4 to be removed

The East Tie-In consists of a new section, which is joined to the east end of the Viaduct and is connected to the south side of Span YB4 as shown in Figure 10.1. The truss opening is sufficient to maintain the horizontal alignment and to provide for five (5) lanes of traffic. Prior to the shifting of traffic and removal of the effected truss members the entire load of the South Truss will be transferred to the new structure as described in more detail for Stages 1 thru 5.

Shifting of traffic as called for in Stage 6 will be completed within the 24 hour allotted closure period. Having shifted traffic onto the new TBS the north side support of the East Tie-In will be constructed and portions of the north side of Span YB4 will be removed along with the north truss as shown in Stages 1 thru 9.

The East Tie-In is supported at its West End by a cantilever section extending beyond Bent 52, a new bent designated Bent 53 and existing Pier E-1. A modular expansion joint shall be at its West End placed to provide for both thermal and seismic longitudinal movements. The East Tie-In is tied both longitudinally and transversely to Bent E1.

The East Tie-In is composed of a structural steel frame supported by cantilevered arms of the steel viaduct, concrete Bent 53 and the existing E-1. The structural steel frame is composed of large steel box girder sections, which provide support for both the upper and lower decks. The superstructure is continuous from the cantilever end to Pier E1. The anchorage at Pier E1 shall be designed for 3 X DEE providing a safety factor of 3 for the design earthquake of the East Tie-In. It is assumed that Pier E1 will resist the imposed seismic forces of the East Tie-In and the cantilever truss to the east of Pier E1 for DLS design earthquake. The longitudinal design displacement of Pier E1 for this event will be 50mm for DEE and 150 mm for DLS. The transverse design displacement is assumed to be zero.

A load limiting device as shown in Figure 4.7.1b is placed at the connection between Pier E1 and the East Tie-In. Where is Figure 4.7.1b?The load limiting device is unidirectional and will limit the loads imposed on the East Tie-In in the transverse direction.

10.1 Existing YB4 Span (Note that allowable strength limits are in accordance with Load Factor Design methods specified in BDS)

10.1.1 Reinforced Concrete Original 1934 (Assumed)

Concrete: $f_c' = 3000 psi,\ f_c = 1200 psi,\ n = 10$

Reinforcement: $f_y = 33 ksi$

Unit weight (reinforced) = 150 pcf

Steel: $f_y = 36,000\ psi,\ fu = 55,000\ psi$

10.1.2 Structural Steel Original 1934: (Assumed)

$f_y = 37,000 psi,\ f_u' = 62,000 psi$ (carbon steel)

$f_y = 45,000 psi,\ f_u' = 80,000 psi$ (silicon steel)

10.1.3 Lightweight Concrete 1964 Modifications:

$f_c' = 4500 psi,\ f_c = 1800 psi,\ n = 15$

Reinforcement – Intermediate Grads:

$f_y = 40 ksi$ per CRSI (As-Builts)

10.1.4 Structural Steel 1964 Modifications:

A440: $f_y = 45,000\ psi,\ fu = 55,000\ psi$

T1: $f_y = 100,000\ psi,\ fu = 115,000\ psi$

(Note test samples maybe taken for portions of YB4 Span to be removed)

Unique elements of the existing YB4 span that are to be reutilized for the East Tie-In shall be tested by the Contractor to verify assumed properties listed above.

11. EAST TIE-IN CONSTRUCTION STAGING AND OPERATIONS

The East Tie-In shall be constructed in stages as described herein. Each stage shall be designed to resist the imposed service loads and seismic loads. A typical section of the roadway at Bent 53 is shown in Figures 11.1 thru 11.9 to demonstrate the various stages. A typical section of the existing roadways supported by the YB4 Span Truss is shown in Figure 11.0. There are five (5) lanes of traffic in each direction, the upper deck carrying west bound traffic and the lower deck carrying east bound traffic.

11.1 Monitoring and Contingency Plan

The Contractor shall submit a monitoring plan for continuous monitoring and documenting the jacking operations on the YB4 span. The Contractor shall identify the major risks associated with the jacking operations and develop a contingency plan to mitigate these risks. Contingency actions such as requirements for reliable power sources, and adequate staffing shall be included in the plans. Back up equipment and alternative plans for safety and time-critical operations shall be provided. The plan shall also include the following:

Sensitivity Studies:
Prior to jacking from box girder beams, contractor shall verify estimated dead load by performing lift-off at Pier E1. Based upon the actual load on structure, designer shall determine what adjustments are needed for tolerances of forces and displacements at each panel point. The monitoring and contingency plan shall provide tolerances to ensure no member is overstressed. The calculated force, displacement and associated tolerances shall be provided incrementally for each 1/2" displacement at midspan.

Stress Consideration:

Throughout the jacking and demolition operations, stresses due to a combination of dead loads and jacking loads in the existing truss members and their end connections shall not exceed 90% of their allowable strength limits All existing posts, diagonals, floor beams and primary load carrying members shall be protected from any permanent damage even if they are not utilized in the completed ETI. Strain gauges shall be provided on all posts and diagonals to ensure member forces are relieved to zero stress during the jacking operation.

Stability Considerations:

Throughout the jacking and demolition operations, stability of existing truss verticals shall be ensured by providing temporary or permanent lateral supports or positive connections to other stable members.

Deactivations and Demolitions:

Deactivation of truss members shall not be allowed unless the member has returned to a zero stress state.

11.2 Construction Staging

Construction Staging shall be modified to incorporate the following:

1) **South and North truss shall be jacked simultaneously to prevent any racking of the truss system. Both trusses shall jacked from directly below the chord members.**

2) **Support system on north and south side shall be similar. (ie. Provide box girder support beam and C-Bent configuration on north side to match south side.)**

This section describes the construction staging that shall be used for the East Tie-In structure. A survey will be conducted, prior to final design, jointly by Caltrans and the Contractor's Engineer to establish the existing condition of Span YB4. All components will be inspected to determine their condition and adequacy for the entire staging process and final configuration. The survey will establish a base line from which to determine any damage that could result from the load transfer. Contractor shall repair any components that are damaged as a result of the jacking operation.

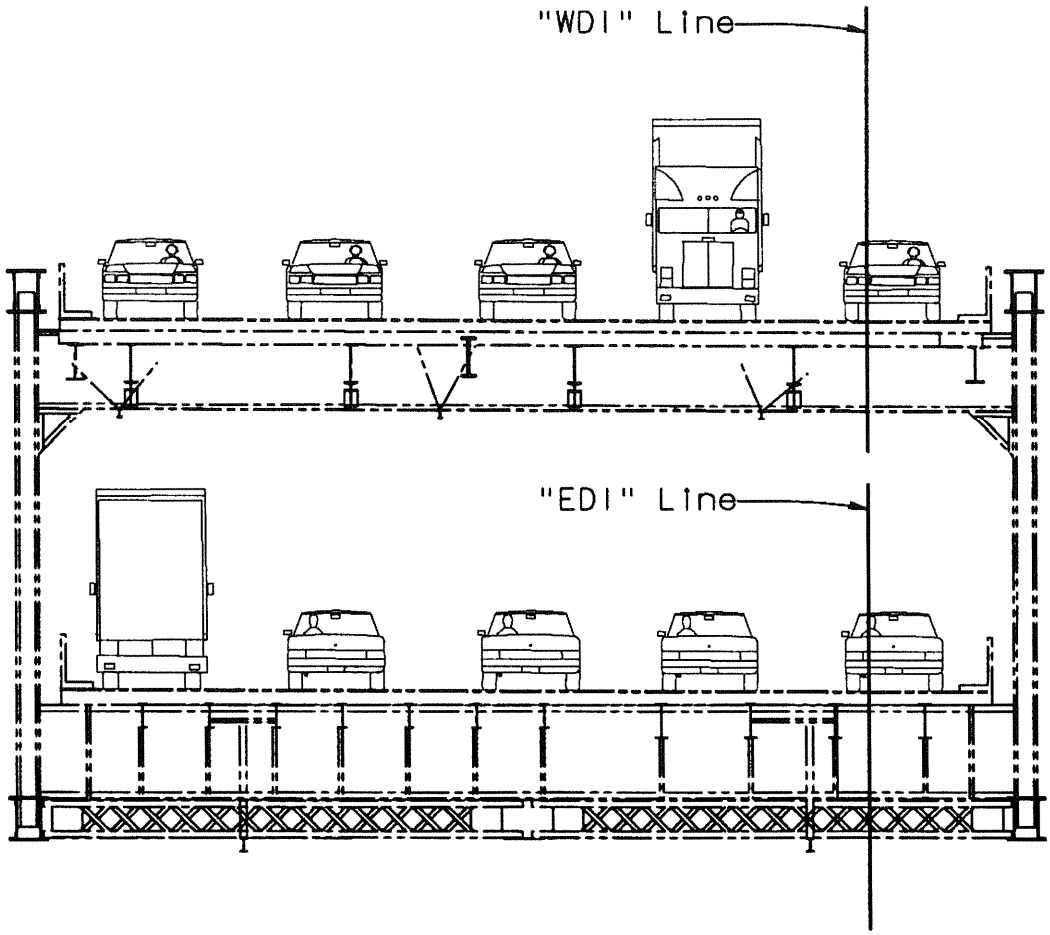


Figure 11.0: Typical Section-Existing YB4 Truss Span

STAGE 1

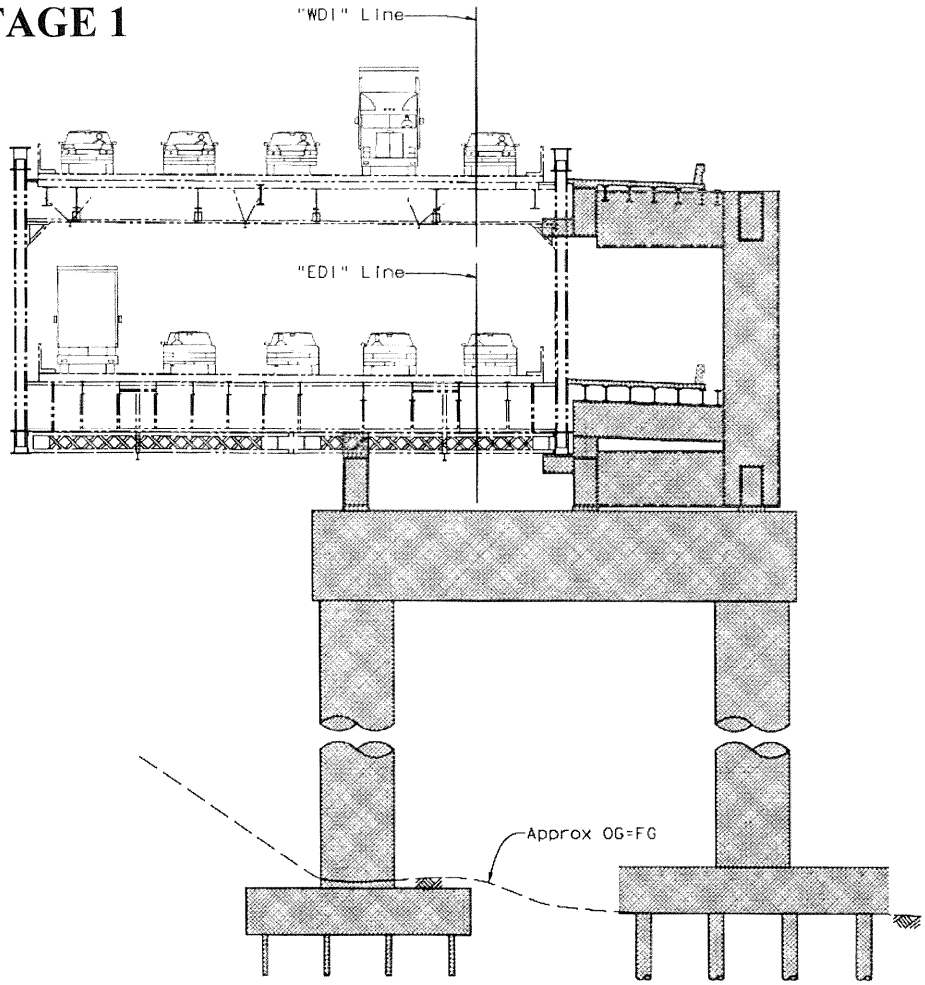


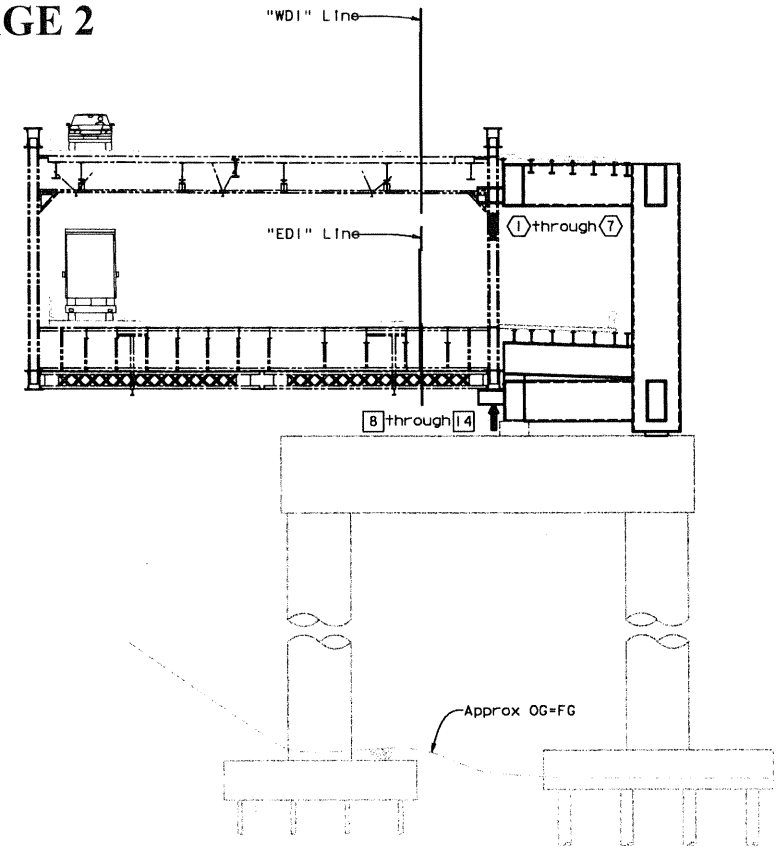
Figure 11.1: Stage 1 – Construction of South Segment Prior to Connection

Stage 1 as shown in Figure 11.1 basically includes the construction of the new South Segment prior to the connection to the existing Span YB4. At this stage the existing span is in its as-built condition. The South Segment is complete with decking to the closure pour. The construction of the concrete Bent 53 is complete and supporting the steel box sections are in place. The barriers along the south edge of the roadway are also in place. The connections to existing YB4 includes:

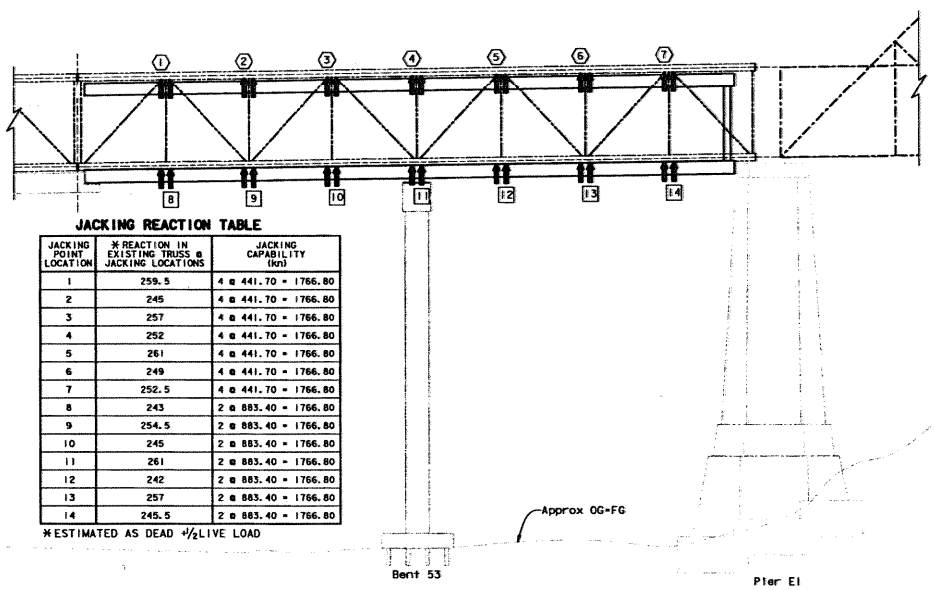
Upper Deck Jacking Brackets and Pedestals
Lower Deck Jacking Brackets and Pedestals
Steel Posts and Bracket connections to Existing Floor Beams
Steel Pedestals Supporting Lower Deck Floor Beams

At the completion of this stage there is no connection between the new and the existing structures.

STAGE 2



a) Typical Section View



JACKING REACTION TABLE

JACKING POINT LOCATION	*REACTION IN EXISTING TRUSS @ JACKING LOCATIONS	JACKING CAPABILITY (kn)
1	259.5	4 @ 441.70 = 1766.80
2	245	4 @ 441.70 = 1766.80
3	257	4 @ 441.70 = 1766.80
4	252	4 @ 441.70 = 1766.80
5	261	4 @ 441.70 = 1766.80
6	249	4 @ 441.70 = 1766.80
7	252.5	4 @ 441.70 = 1766.80
8	243	2 @ 883.40 = 1766.80
9	254.5	2 @ 883.40 = 1766.80
10	245	2 @ 883.40 = 1766.80
11	261	2 @ 883.40 = 1766.80
12	242	2 @ 883.40 = 1766.80
13	257	2 @ 883.40 = 1766.80
14	245.5	2 @ 883.40 = 1766.80

*ESTIMATED AS DEAD +1/2 LIVE LOAD

b) Elevation View

Figure 11.2: Load Transfer of South Segment
Stage 2

Stage 2, as shown in Figure 11.2, involves the load transfer of the South Truss from the YB4 span to the new South Segment. The North Truss will be jacked along with the South Truss to prevent racking of the truss system. This stage begins with the installation of the jacking system and the geometry monitoring system. The jacking system consists of lock nut hydraulic cylinders (jacks), calibrated pressure gauges, a hydraulic pressure source (pump) and the jacking control system (distribution manifold(s) and valves). The geometry monitoring system shall consist of strategically placed control point targets and optical surveying instruments with distance measuring capabilities (total station). The jacking and geometry monitoring systems shall be such that the jacking pressures and the structure geometry can be measured at any time during the load transfer.

Calibrated pressure gauges for each jacking location will be used to monitor the total jacking load applied. The total jacking load applied at a jacking point will be determined as the product of the effective cylinder area(s) and the calibrated pressure. Each pressure gauge will be calibrated and certified at the manufacturer's facility and the corresponding documents submitted for field use. The effective cylinder areas will be certified by the jack manufacturer. The jacking control system shall be capable of isolating any and all jacking locations for individual adjustment of the applied jacking load. A schematic drawing shall be provided showing all components of the jacking system and the hydraulic circuits.

Absolute structure displacements shall be kept within ±150mm of the current roadway position and the induced roadway superelevation must be maintained. During the jacking operation the hydraulic jack pistons cannot be extended more than 10mm above the hydraulic cylinder without a redundant support system. When public traffic will be carried over the bridge during jacking operations, the Contractor's jacking method shall include provisions for blocking up the superstructure from the new beams or falsework such that there will be a gap of less than one inch between the falsework and the superstructure during all phases of the jacking operations.

The superstructure shall be jacked and adjusted to grade uniformly and in such a manner that a roadway satisfactory for the used of public traffic is provided in conformance with the provisions in Section 7-1.08, "Public Convenience," of the Standard Specifications.

Description of Stage 2 Construction Activities:
- Existing truss in its as-built condition still in service
- Jacking system installed includes jacking brackets
-Jacking is performed simultaneously at all jacking points to raise the south and north truss and reduce the predicted pre-existing dead load and anticipated live load member forces to nearly zero. This zero member-force condition exists when the trusses are raised by applying prescribed jacking loads not to exceed the fabricated no-load camber as determined from the archives of design and shop drawings. Once this condition is achieved, the lock nuts on the jacks are seated. Any additional live load will be carried by the mechanically locked jacks. The jacking loads are established from the dead loads of existing YB4 (i.e., dead load shears of existing floor beams and tributary weight of truss members at every panel point plus to appropriate live load as described below.

-Pressure transducers for each jack will be used to monitor the total jacking load applied to be:

- Not more than the estimated dead load reactions if the bridge is temporarily closed to traffic
- Not more than the estimated dead load reactions plus 50% of the live load if the bridge is partially closed
- Less than or equal to the dead load reactions plus the full live load.

-Displacement transducers will be used to monitor and adjust elevations and relative displacements of the two structures at each jacking point.
-Traffic on the bridge shall be significantly reduced for the jacking operation (Through 3 or more lane closures, after midnight) for a few hours.

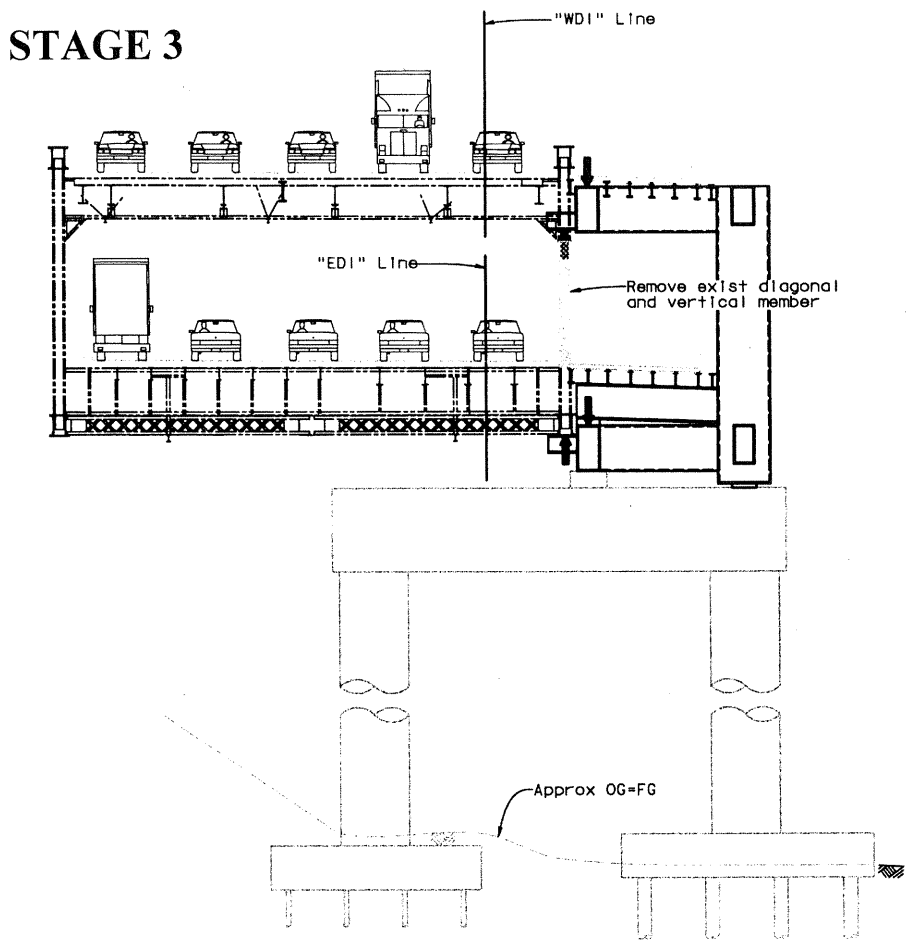


Figure 11.3: Stage 3 – Removal of Portions of South Truss

Description of Stage 3 Construction Activities:

-Diagonal, vertical and top chord members of the south truss will be deactivated (cut) in a predetermined sequence while each jacking point is supported by the mechanically

locked jacks. At any time during the deactivating process the applied jacking load at any point can be determined by performing a hydraulic lift-off of the locking nut(s). Load and geometry adjustments can be performed at any time during the deactivation process. -Upon removal of a truss member, the hydraulic Jacks in the locked condition will carry any new live loads and any dead loads (in addition to those estimated) of the south truss. After cutting, comparison of the actual jacking with the analytical results will be made and necessary adjustment will be made for subsequent cutting.

DL: +Existing YB4 Truss
+Entire Existing Deck
- Jacking Dead Loads, Existing
LL: - Reduced Lanes of Traffic (Maximum 5)

DL: +New Steel Frame
+New Concrete Deck
+New Barriers
+Jacking Dead Loads, New
LL: +Tributary Live Load Transfer due to Jacking, (Maximum 1/2 of full 5 lane of traffic)

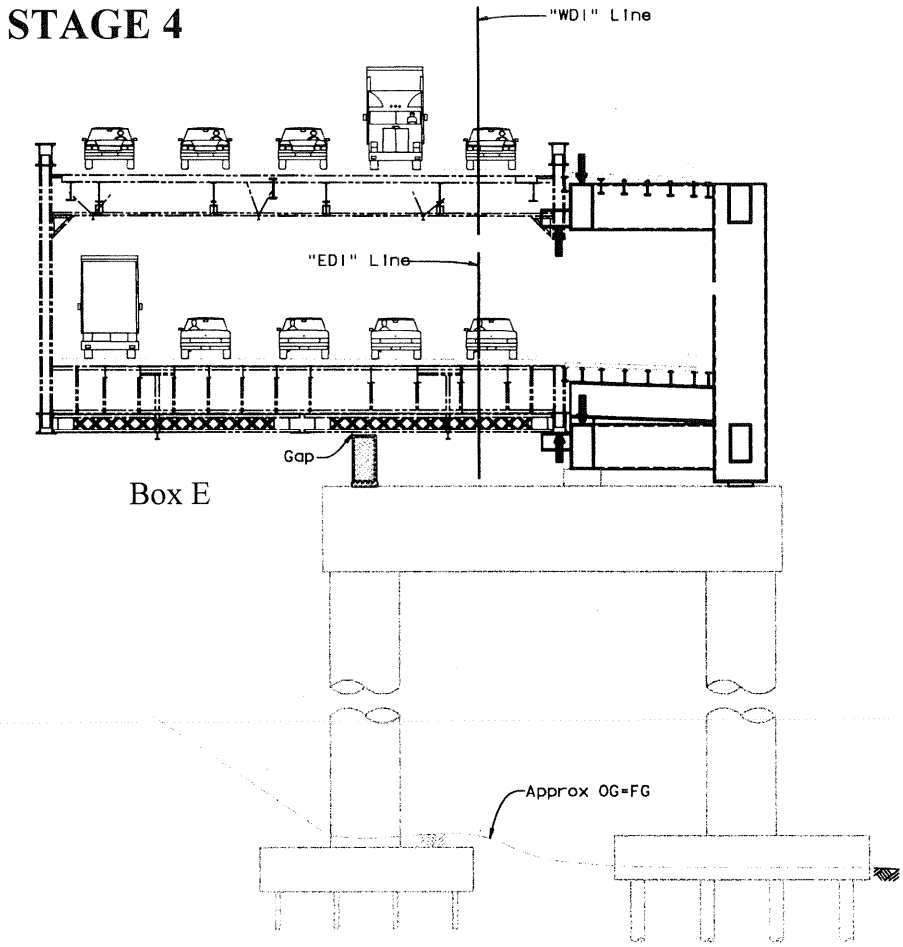


Figure 11.4: Stage 4 – Construction of North Segment Support System

Stage 4 will include the placement of the North Box Girder E as shown in Figure 11.4. The existing North Truss will remain in service. No load transfer to girder "E" will occur in this stage. The pedestals will be placed, but not yet bolted to the floor beams.

- Description of Stage 4 Construction Activities:

-Existing north truss in its as-built condition still in service
-The north box girder 'E' is erected.
-Pedestals are erected but not bolted to floor beams.
- During this stage, no load transfers from lower deck to box 'E' is assumed.

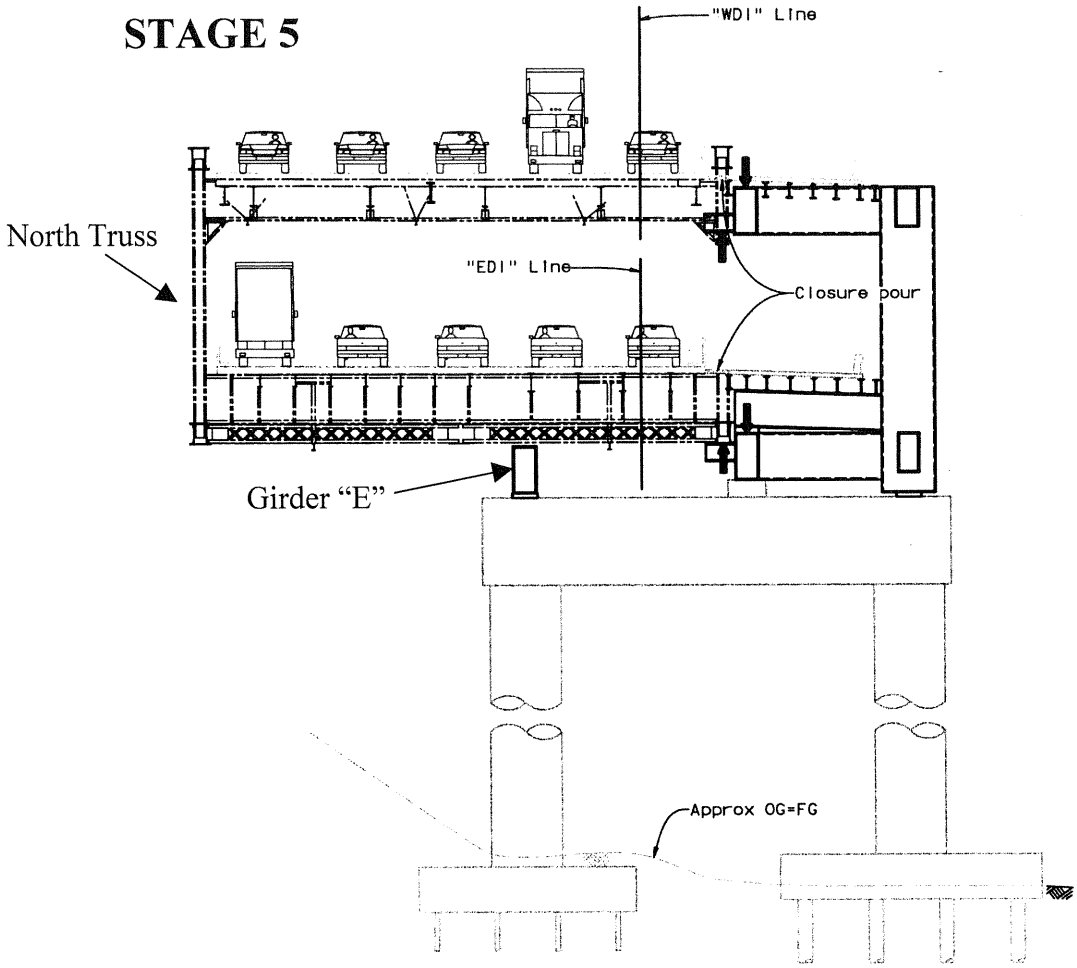


Figure 11.5: Stage 5 – Closure Pour for South Segment

As shown in Figure 11.5 this stage includes the closure pour between the South Segment and the south edge of the existing Span YB4.

STAGE 6

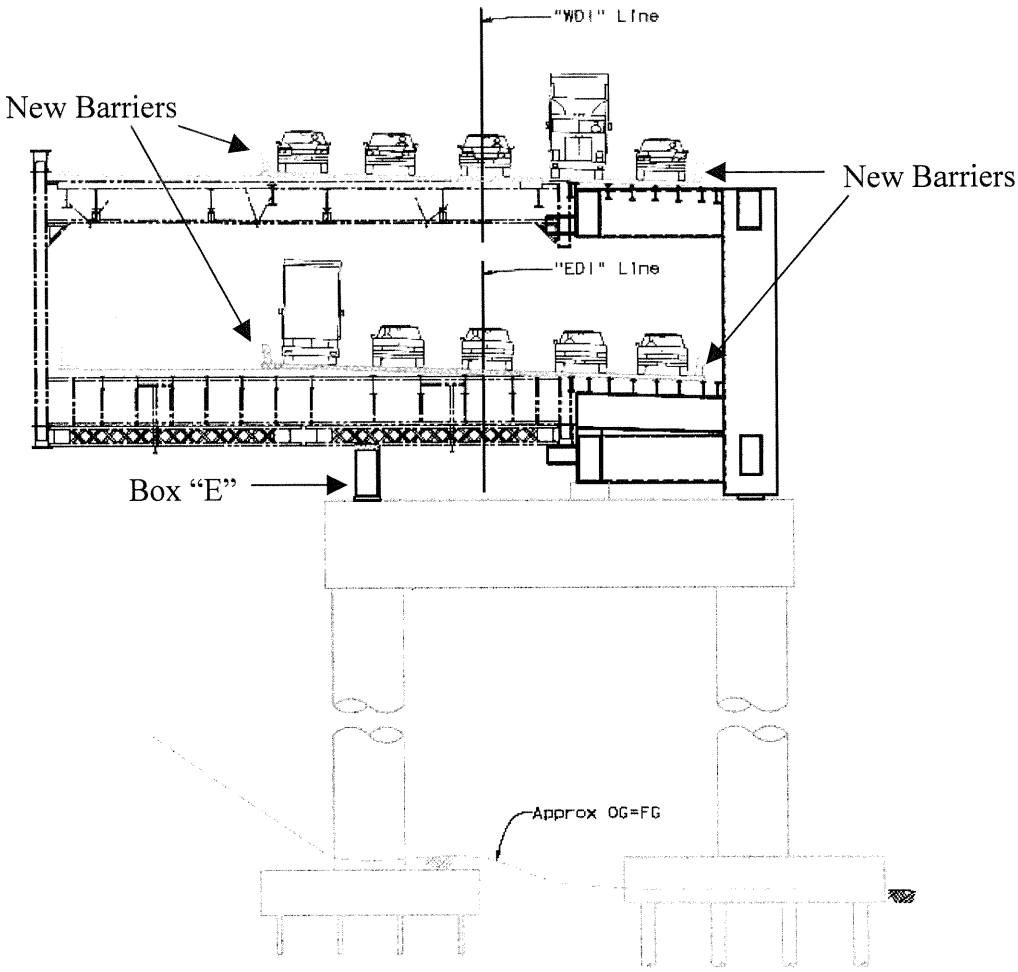


Figure 6: Stage 6 – Traffic Shift

Stage 6 is the barrier change on the north side and the traffic change onto the new South Segment. The existing North Truss in the existing condition is still in service. The pedestals are shimmed to snuggly fit against the floor beams for fastening. A small portion of the live loading will be transferred to Box E at this stage.

STAGE 7

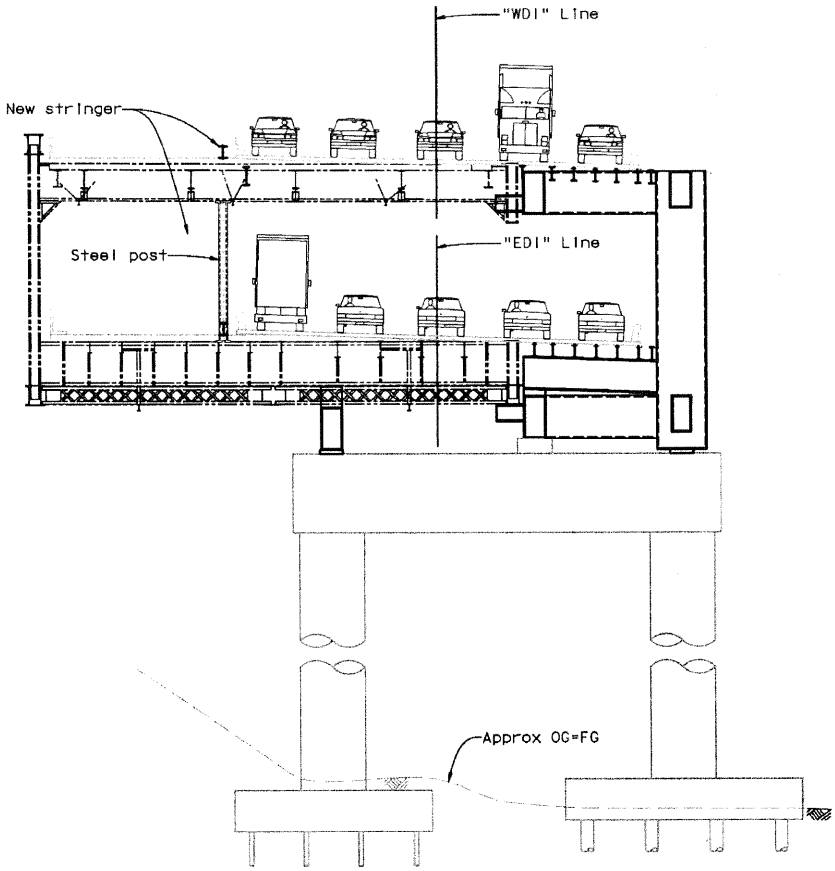


Figure 11.7: Stage 7 – Placement of Upper Deck Support

Stage 7 as shown in Figure 11.7 includes the placement of the stringers on the upper and lower decks, which are tied to the concrete deck. The steel posts are erected to fit snuggly between the upper and lower floor beams. Following the placement of the vertical posts the steel cross bracing and brackets shall be installed to provide stability to the post both in plane and out of plane of the braced frame system. The load transfer from the upper deck to the lower deck and ultimately to the Box E is limited at this stage with the North Truss still a major part of the total load resisting mechanism.

DL:	+Existing YB4 Truss	
	+Entire Existing Deck	
	- Jacking Dead Loads,	Existing
LL:	+ X Lanes of Traffic	
DL	+New Steel Frame	
	+New Concrete Deck	
	+New Barriers	
	+Jacking Dead Loads,	New
	+ Full Weight Deck Closure,	

LL: +Tributary Live Load, Transfer due to Jacking,
+4 Lanes of Traffic

Description:

- Existing north truss in as-built condition still in service.
-The steel posts are erected by lightly jacking to fit between the floor beams above and below.
- The steel cross-bracings and brackets are installed to provide stability of post in both in-plane and out of plane of the braced frame system.
- Erect new stringer and anchor to deck to support north portions of the deck prior to demolition.
-Load transfer from upper and lower deck to box 'E' is assumed limited, considering that the north truss is still in service and mainly carrying the loads.

STAGE 8

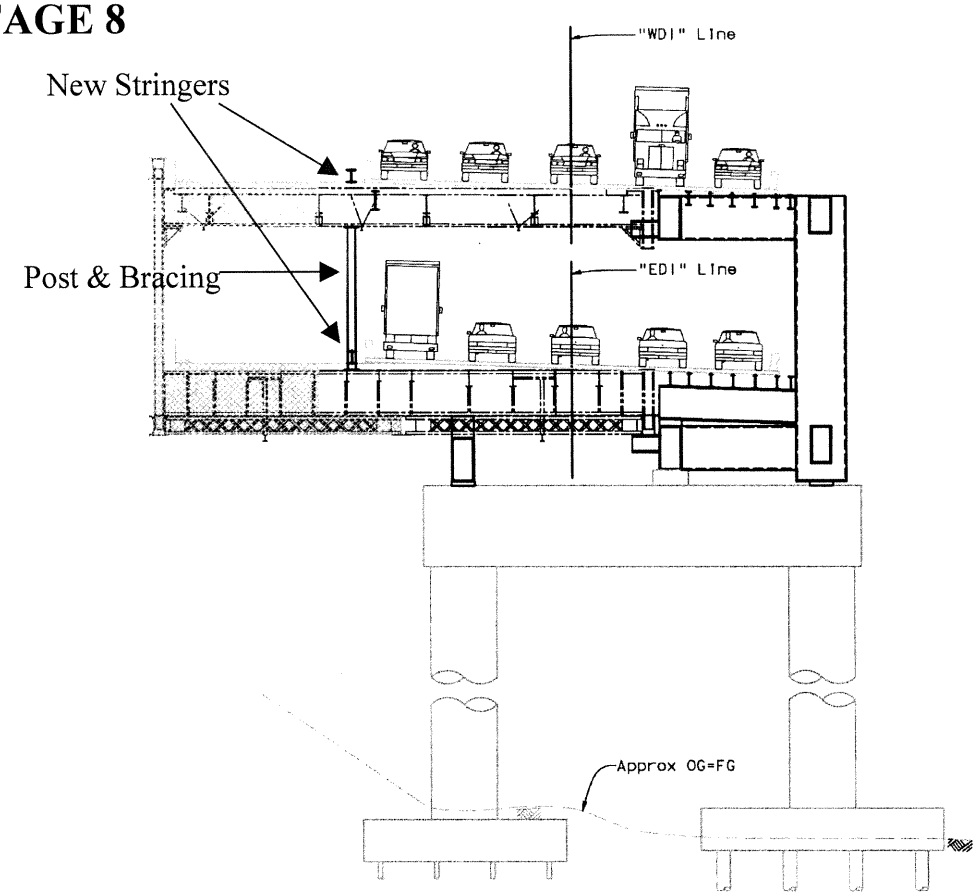


Figure 11.8: Stage 8 – Load Transfer and Demolition of the North Portion of the Span

This stage includes the load transfer from the existing North Truss to Box Girder E and removal of the north portions of the upper and lower decks and the North Truss.

DL: +Remaining South Portions of Existing Deck

- Reduced Jacking Dead Loads, Existing
LL: + X Lanes of Traffic

DL: +New Steel Frame
+New Concrete Deck
+New Barriers
+Reduced Jacking Dead Loads, New
+ Full Weight Deck Closure,
LL: +Tributary Live Load, Transfer due to Jacking,
+ Y Lanes of Traffic

Description:

- Demolish north portions of the upper and lower decks.
- Flame cut north portions of upper and lower deck floorbeams while adequately bracing the north truss.
- Upon cutting of the floor beams and removal of the north truss, all dead and live loads of the remaining portions of the existing truss will be carried by box E.

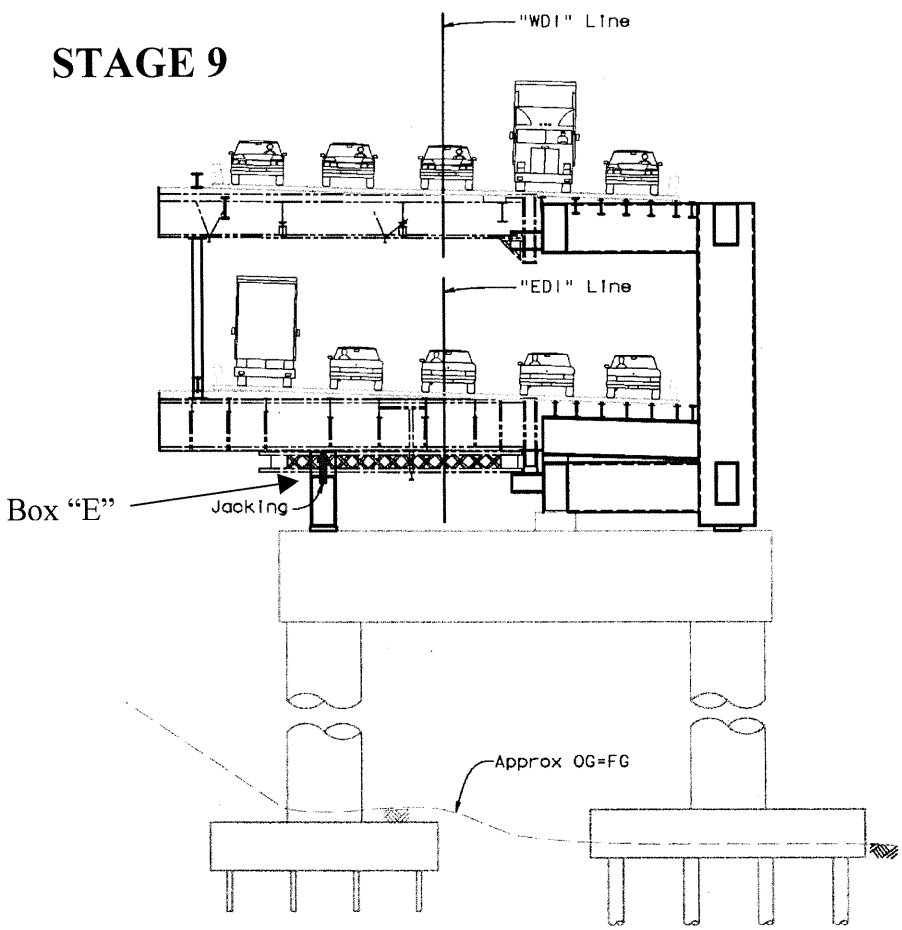


Figure 11.9: Stage 9 –
Adjust Profile and Superelevation

DL: +Remaining South Portions of Existing Deck
- Reduced Jacking Dead Loads, Existing
LL: + X Lanes of Traffic

DL: +New Steel Frame
+New Concrete Deck
+New Barriers
+Reduced Jacking Dead Loads, New
+ Full Weight Deck Closure,
LL: +Tributary Live Load, Transfer due to Jacking,
+ Y Lanes of Traffic

Description:

-Adjusting the elevation of the lower and upper deck floor beams by simultaneously jacking at all floor beam pedestals supported on Box E.
-Placing shim plates and permanently bolting of pedestals to Box E.