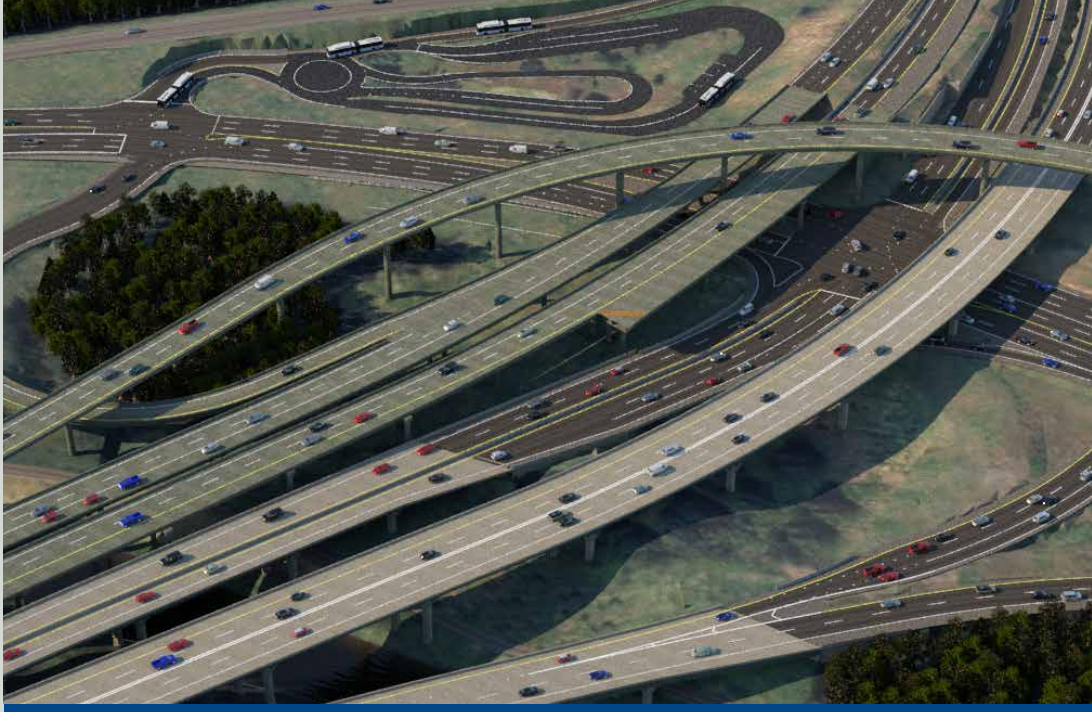

ATC1 | Use of Pier Wall for Bridges 405/103E and 405/103

Washington State Department of Transportation

I-405/SR 167 Program
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Bellevue, WA 98004
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April 3, 2023

Kyle Sharrer
6100 219th Street SW Suite 300
Mountlake Terrace, WA 98043

RE: ATC 01 Rev 2: Use of Pier Wall for Bridges 405/103E and 405/103W
I-405, Brickyard to SR 527 Improvement
Design-Build Project

Dear Mr. Sharrer:

The Washington State Department of Transportation (WSDOT) has reviewed ATC 01, Use of Pier Wall for Bridges 405/103E and 405/103W Rev 2, as submitted on March 31, 2023. WSDOT's determination regarding this ATC is as follows:

The ATC is approved.

If you have any questions, please contact me directly at (425) 495-1577.

Sincerely,

Evelyn C. Pao, P.E.
Project Director

ECP:hth
Enclosure: ACT #1 – 228th – Rev 2

cc: D. Case
H.T. Huynh

ATC #1 | Use of Pier Wall for Bridges 405/103E and 405/103W

Brief Description

The Design Builder proposes ATC-01 which consists of using Pier Walls at the intermediate Piers 2 and 3 for existing Bridges 405/103E and 405/103W and eliminate the new column for bridge 405/103E. This ATC also eliminates the steel jacket requirements for 1960s columns and the Pier Cap bolters for the intermediate Piers for both bridges.

Detailed Description

Executive Summary:

According to the as-built drawings provided by WSDOT, Bridges 405/103E and 405/104 were originally built in the 1960s and widened in the late 1990s and they carry the main line of I-405 over 228th SE Street. The sub-structure consists of cast-in-place columns supported by spread footings embedded about 10' below the existing grade. From the as-built drawings, it can be observed typical deficiencies from the 1960s design, like lack of shear and confinement in the columns due to stirrups spacing in the order of 12". In consequence, these 2 bridges shall be retrofitted to meet the Recovery (Lifeline) requirements in the WSDOT BDM.

The Design Builder is proposing to use Pier Walls for both bridges at all Intermediate Piers for both bridges. These Pier Walls will act as shear wall in between the existing columns and as an extended shear wall for the new widening for Bridge 405/103E. The new columns, and the steel jacket retrofit for the existing columns are proposed to be eliminated. The goal of the proposed ATC is to meet the Ductility-Demand Seismic Requirements for Recovery-Level Bridges and reduce traffic impact during construction by eliminating the need for the new columns and shafts for Bridge 405/103E.

Background – Concept Design:

Reference:

1) WSDOT Bridge Design Manual (BDM).

2) AASHTO Guide Specifications for LRDS Seismic Bridge Design (AASHTO SEISMIC).

RFP Section 2.13.4.1.1 Bridge Seismic Design criteria, page 2.13-9, lines 24 to 26, indicates that "All new, widened, modified, and seismic retrofitted bridges carrying I-405 mainline and ramps to and from I-405 mainline shall have an operational classification of Recovery as defined in the WSDOT Bridge Design Manual. The WSDOT BDM Section 4.1 indicates Recovery Bridges serve as vital links for rebuilding damaged areas and provide access to the public shortly after an earthquake. The role of Recovery Bridges as Lifelines can be observed in WSDOT BDM Table 4.1-2, where the Displacement Ductility Demand is limited when compared to ordinary Bridges.

RFP Section 2.13.4.1.2, Bridge Widening Design Criteria (after Addendum 8), page 2.13-10, lines 18 through 22, 28 indicates Bridge 405/103E shall include Infill shear wall in between each column, steel column jackets on each column shall be provided as required, and cross beam strengthening with bolsters at intermediate piers shall be provided. In addition, lines 28 and 29 indicates shallow spread

footings at the intermediate piers shall be made continuous to form a continuous beam across the pier.

RFP Section 2.13.4.1.14 Bridge Widening Criteria, indicates Bridge 405/103W shall include steel jackets for the 3 western columns built prior to 1980.

Existing Configuration:

The existing bridge 405/103E carries Northbound (NB) I-405 over 228th Street SE; and the existing bridge 405/103W carries Southbound (SB) I-405 over 228th Street SE. Both bridges were built in the late 1960s and widened in the late 1990s.

Conceptual Plan:

The conceptual plan configuration for Bridge 405/103E (Appendix M1, drawing BR-08) proposes using Infill Walls for retrofitting the columns and building two new columns under the widening. Figure 1 presents an extended elevation of the Infill Walls (from BR-08), including the existing South Fork Perry Culvert. It can be observed that the existing culvert is penetrating through the Infill Wall.

Design Challenges:

Steel Jacket Solution: Using steel Jackets for retrofitting the existing columns only provide additional confinement and shear capacity. This solution doesn't help limiting the ductility demand as required in WSDOT BDM Table 4.1-2 for Recovery Bridges. Also, using steel jackets in combination with an Infill Wall is not practical because, holes will be required through the steel casing in order to create a composite action between the column and the Infill Wall. These holes will be detrimental to the confinement (hoop) effectiveness of the steel casing.

Liquefaction: Some liquefiable soils are found within the soil profile and needs to be considered.

Bridge 405/103E: The Design-Builder's interpretation of the requirement of new columns and drilled shaft at the widening area is to protect the existing culvert running under 228th Street SE and to mitigate the potential liquefaction risk at the Pier 2 and 3 locations. The Design Builder developed the attached figures illustrating that the existing culvert is above the spread footing level therefore, it isn't affected by the spread footing bearing pressure.

Bridge 405/103W: Using steel Jackets for retrofitting the existing columns only provide additional confinement and shear capacity. This solution doesn't help reducing the ductility demand as required in WSDOT BDM Table 4.1-2 for Recovery Bridges.

ATC Description:

The Design-Builder is proposing mitigation measures for the liquefiable soil within the footprint of the proposed excavation for the Pier 2 and 3 footings. The zones of potential soil liquefaction within the footprint of the excavation for the proposed Pier 2 and 3 foots will be removed and replaced with WSDOT compliant compacted structural backfill thus mitigating the potential liquefaction at

those locations as described in the Design Analysis section below.

The most efficient way for limiting the Displacement Ductility Demand for existing bridges is by introducing Infill or Pier Walls, which even though have lower Displacement Ductility Demand requirements than Column Bents, they are stiffer and therefore, the Seismic Displacement Demand is reduced.

The Design Builder will protect in place the existing culvert during construction. The design and detailing of the Pier Wall at Bridge 405/103E, Pier 3 will consider the presence of the existing culvert by providing an oversized penetration through the Pier Wall for the pipe culvert.

This ATC will provide the following design for each bridge:

1) The zones of potential soil liquefaction within the proposed excavation for Piers 2 and 3 will be removed and replaced thus mitigating the potential liquefaction at those locations as described in the Design Analysis section below.
2) Abutment for the widening portion of Bridge 405/103E will be designed to consider the limited settlement due to the presence of the liquefiable layer in that area (see more explanation in the structural adequacy section below). No Ground Improvement and/or Soil replacement is proposed in this ATC, which matches the intent of the RFP document and conceptual drawings.
3) For the Intermediate Piers, spread footings will be combined and capacity protected to the overstrength demand from the Pier Wall along its weak axis. Please, note the final design of combining the spread footing and the existing drilled shaft will be determined during final design. The concern is to avoid inducing excessive shear demand into the drilled shaft by combining the drilled shaft with the spread footing.
4) A Pier Wall will be provided for Piers 2 and 3 as shown in Figure 2 (attached).
5) Girder seat extension and girder stops at abutments are needed.
6) For Bridge 405/103E, the Pier diaphragm and Pier Cap will be widened to match the existing structure.

This ATC will eliminate the following design components:

1) Bridge 405/103E:
   a. New columns and drilled shaft under the widening will be eliminated from the design.
   b. Bolsters will not be provided for the Pier Cap for Piers 2 and 3 due to the presence of the Pier Wall acting as a deep beam in between columns.
2) Bridge 405/103W:

a. Steel Jackets for columns built before 1980. The existing columns acting in composite with the new Pier Wall will have enough ductility capacity to withstand the seismic demand.

b. Bolsters will not be provided for the Pier Cap for Piers 2 and 3 due to the presence of the Pier Wall acting as a deep beam in between columns.

Usage

This ATC will be used for Bridges 405/103E and 405/103W.

Subsurface Investigation

No additional subsurface investigations will be required during procurement for this ATC. During post-award design, geotechnical explorations will be used to further define the lateral extents of the potential liquefaction for the purposes of more accurate slope stability analyses in the vicinity.

Hazardous Materials Investigation

No hazardous materials will be produced related to the ATC.

Proposed RFP Modifications

The Design Builder requests the following modifications to the RFP:

Chapter 2 Technical Requirements:

1. Section 2.13.4.1.2, Bridge Widening Criteria, page 2.13-11, lines 3, 4 and 5:
   a. Modify this sentence: "Foundations for widening of Bridge 405/103E shall be designed to impose no load or deformation on the South Fork Perry Creek culvert. Existing Culvert shall be protected in place at all times."
2. Section 2.13.4.1.14, Bridge Seismic Retrofit Design Criteria, page 2.13-17, lines 29 and 30:
   a. Replace this: "For Bridge No. 405/103W, provide steel column jackets for the three western columns at Pier 2 and 3 (columns built prior to 1980)."
   b. For this: "For Bridge No. 405/103W, provide Infill Wall at Pier 2 and 3.

Design Analyses

This ATC does not require a design analysis, Design Builder is responsible for submitting structural calculations to satisfy WSDOT's requirements.

Analysis

Skanska and AECOM have conducted a thorough analysis to demonstrate how ATC #1 provides WSDOT with an "equal or better" project.

ATC #1 | Use of Pier Wall for Bridges 405/103E and 405/103W

a) Functionality

ATC #1 does not affect functionality.

b) Structural adequacy

This ATC improves structural adequacy by meeting the Seismic Ductility Demands of WSDOT BDM.

Additionally, the zones of potential soil liquefaction at bridge 103E were evaluated; however, the liquefaction potential was evaluated based on the provided borings in the vicinity of these two bridges: the southern boring (NE 41-19) doesn't have liquefiable soils and the northern boring (NE-42P-19) only exhibits liquefaction potential in a 3' thick soil layer between Elevation +99' and +96', with resulting liquefaction-induced settlement of 0.2 to 0.4 inches. Given that the soils with liquefaction potential are higher in elevation than the proposed Pier 2 and Pier 3 footings, those potentially liquefiable soils above the base of the spread footings will be removed and replaced with well compacted backfill, thus mitigating any potential liquefaction at those locations. Stability analyses have also been performed to show that the stability of the bridge abutments (e.g. Pier 4 sliding down toward Pier 3) meet minimum requirements even without any laterally extensive liquefaction mitigation other than the over excavation and replacement that has been described herein. The static strength limit state factor of safety value is greater than 1.3, the extreme limit state (FEE) pseudo-static factor of safety value is greater than 1.1 (not that liquefaction does not occur under the FEE level seismic loads), and the extreme limit state (SEE) pseudo-static factor of safety value also meets the factor of safety of 1.1 requirement. The post-seismic liquefied extreme limit state cases are in excess of 1.1 for both FEE and SEE events.

c) Safety

This ATC does not affect safety.

d) Comparison of life cycle costs including repair and maintenance

This ATC will not change the life cycle costs for repair and maintenance.

e) Aesthetics

The aesthetics of the permanent facility are unchanged.

f) Impacts on construction traffic

This ATC avoids increasing the limits of construction by avoiding a major seismic retrofit for Bridge 522/28N.

g) Effect on or changes to environmental commitments identified in the RFP

There are no additional impacts or changes to the environmental commitments identified in the RFP.

h) Impacts to surrounding and adjacent communities, including EJ and LEP populations

There are no impacts to surrounding and adjacent communities, including Environmental Justice (EJ) and Limited English Proficiency (LEP) populations.

ATC #1 | Use of Pier Wall for Bridges 405/103E and 405/103W

i) Changes needed in the location, length, height, or number of noise walls

There will be no changes to the location, length, height, or number of noise walls.

j) Impact on utilities and rail

There will be no impact on utilities and rail.

k) Discussion of additional ROW or easements required

No additional right-of-way or easements are required.

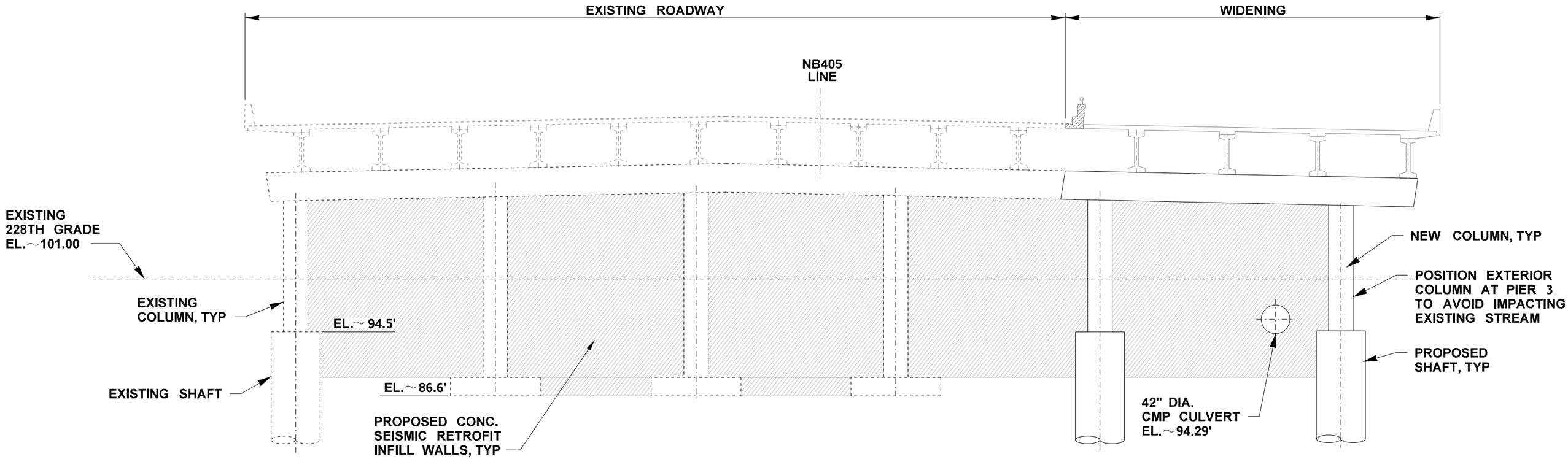
i) An assessment of forward compatibility

There are no impacts to forward compatibility.

Attachments:

Figure 1, ATC-01 Conceptual design for Intermediate Pier 3 for Bridge 405/103E, similar to BR04 (now showing existing Culvert penetrating through the Pier Wall).

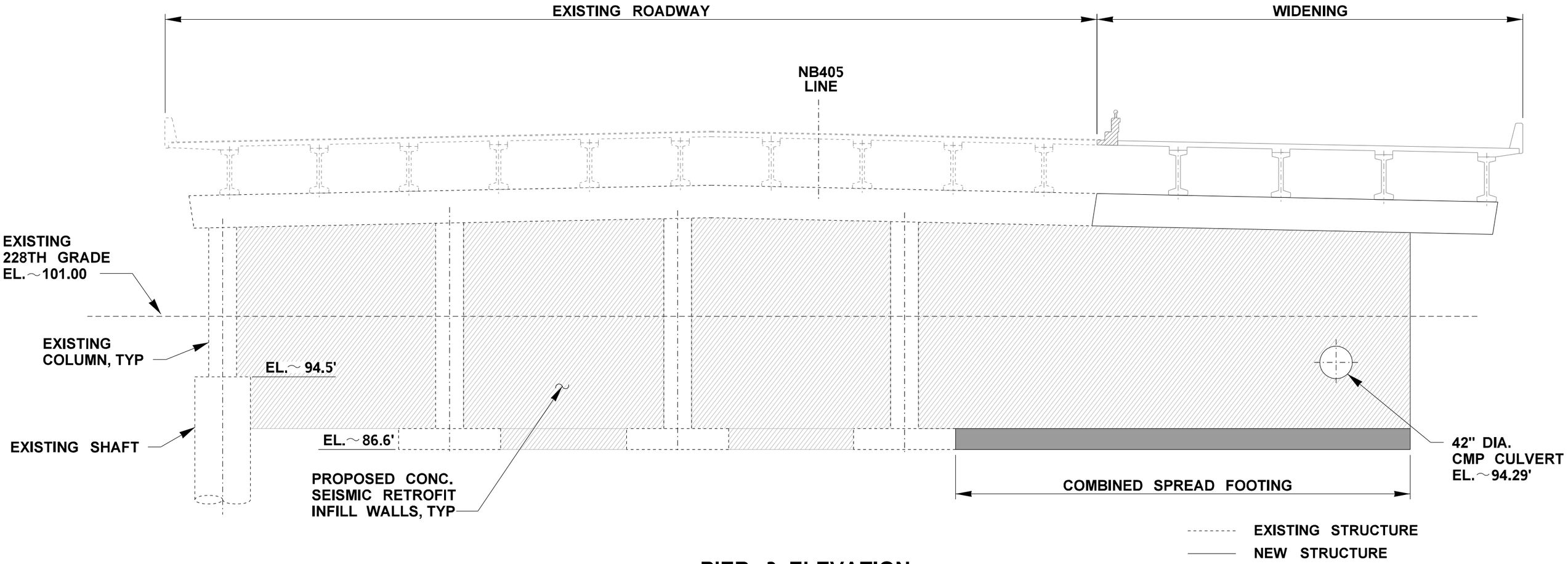
Figure 2, ATC-01 Proposed design for Intermediate Pier 3 for Bridge 405/103E where new columns are eliminated.



PIER 3. ELEVATION

LOOKING AHEAD ON STATION AND NORMAL TO MAINLINE.
VIEW ALONG THE SKEW

EXISTING STRUCTURE
NEW STRUCTURE



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