I-95 HOV/HOT Lanes Project

Exhibit C

Technical Requirements
Attachment 3.4
Settlement of Structures

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Unless approved by the State Structure and Bridge Engineer, the Concessionaire shall design all structures to meet the design requirements listed below:

1. Virginia Department of Transportation Structure and Bridge Division Instructional and Informational Memorandum No. IIM-S&B-80.3 dated January 31, 2011.

2. AASHTO 2010 Bridge Design Specifications, 5th Edition, and with 2010 interims.

3. Foundation settlements shall be investigated using all applicable loads in Service I Load Combination (AASHTO 5th Edition, Section 10.5.2.2).

4. As measured from the bottom of the bridge bearing, or top of pier cap, the settlement limits are defined as follows:

   a. Total settlement of the substructure unit over its entire design life (S_{TOT}) shall be limited to 2 inches with S_{TOT} defined as:

      S_{TOT} = Elastic Settlement + Consolidation Settlement + Secondary Settlement.

      Elastic Settlement includes both that for the soil/rock plus the elastic shortening of the deep foundation element and the pier column.

   b. Total settlement to occur after completion of the bridge to the end of its design life (S_{POST}) shall be limited to 1 inch.

5. Plans shall incorporate the following "General Note" populated with the actual settlement values used in the design of the structure:

   "This structure has been analyzed and designed to accommodate settlement as noted below: Total Settlement of (__)" has been accommodated. The total settlement (S_{TOT}) is defined as the arithmetic sum; S_{TOT} (__)" = Elastic Settlement (__)" + Consolidation Settlement (__)" + Secondary Settlement (__)". In addition, Differential Settlement of (__) radians, as measured center to center between adjacent columns or footings, has been accommodated."

6. During construction and after all settlements have occurred the bridge structure (consisting of the superstructure, substructure and associated elements in the load path) must meet all structural capacity requirements for

all loading combinations requiring such analysis. In addition, the structure must meet all structural capacity requirements for all load combinations for the listed differential settlement (AASHTO LRFD 5th Edition Section 3.12.6).

7. The bearings and substructure shall be designed and detailed to accommodate increases or decreases in loads due to total or differential settlement shown on the plans. The superstructure shall be designed and detailed to accommodate changes in loads, locations of inflection points or fatigue stress ranges. (AASHTO LRFD 5th Edition Sections 3.1, 3.4.1, 3.12.6, 5.7.3.6.1).

8. Creep and/or shrinkage may only be used to offset settlement effects when it occurs CONCURRENTLY with settlement, and the designer is responsible for determining time rate of settlement and creep. [For instance, if all settlement is elastic (instantaneous), creep cannot be used to offset loads imposed].

9. Joint rotations and bearing rotations due to settlement shall be considered in addition to all tolerances for rotations due to live load (LL) effects or for constructability (AASHTO LRFD 5th Edition Section 5.7.3.6.1).

10. Settlements which change super elevation shall not reduce super elevation below the minimum specified by AASHTO for the roadway design speed and roadway type, nor shall they negatively impact the performance of the deck or approach paving.

11. Settlements which change profile grade shall not:
    a. Increase spread of drainage beyond limits specified in AASHTO.
    b. Change performance or maintainability of utilities.
    c. Introduce a low or flat spot on the bridge or reduce the minimum grade specified in the roadway drainage manual.
    d. Negatively impact rideability except as limited by the special provision for rideability.

12. Coordinate predicted/expected settlement of the approach embankments and bridge structure to comply with contract rideability requirements.

13. The structure must be capable of carrying a future wearing surface equal to the magnitude of the total anticipated settlement placed uniformly from curb to curb and abutment to abutment. The total future wearing surface loads, inclusive of any additional loads needed to mitigate for anticipated settlement, shall not exceed 15 psf. All parapets and railings shall accommodate the

additional layer of surfacing with no modification or reduction in crash test level after construction.

14. Jacking and shimming shall not be allowed to correct differential settlement, unless approved by the Department.

15. Settlements shall be treated as a load condition with γ_{SE} = 1.0 for all AASHTO indicated groups. Load combinations which include settlement shall also be applied without settlement (AASHTO LRFD 5th Edition Section 3.4.1).

16. Differential settlement at a single substructure unit shall be limited to a vertical value which does not exceed a slope from the horizontal of 0.001 radians as measured center to center between adjacent columns or footings within the same substructure unit.

17. When differential settlement at a single substructure unit is anticipated, both the superstructure and substructure shall be analyzed and detailed to account for the changes resulting from differential deflection.

18. Under no condition shall settlement be used to justify use of simple span configurations instead of continuous span configurations.