

VDOT Northern Virginia Traffic Signal Workshop, 2015



ANCILLARY STRUCTURES DESIGN

July 20, 2015

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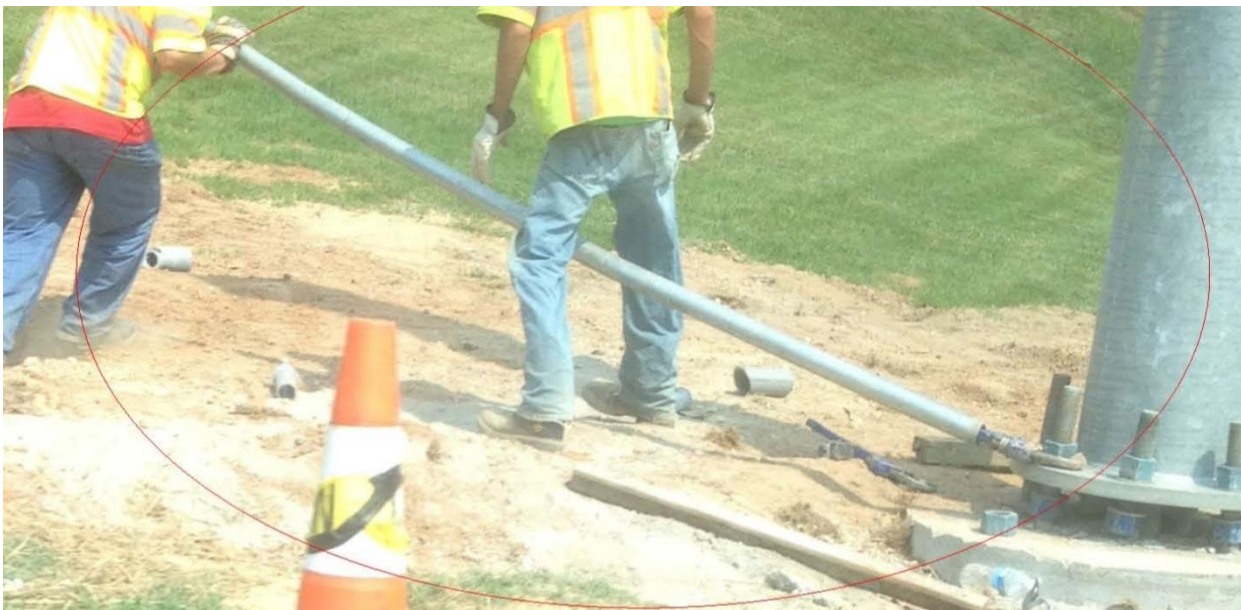
Section Manager, Structure and Bridge

TOPICS

- **Special Provision for Nut Tightening**
- **Updates to Road and Bridge Standards and I&IM-90**
- **Updates to I&IM-90 to address adoption of *2013 AASHTO Standard Specifications for Highway Signs, ...***
- **Signal Brackets**
- **Light Poles**
- **LRFD**

Nut Tightening

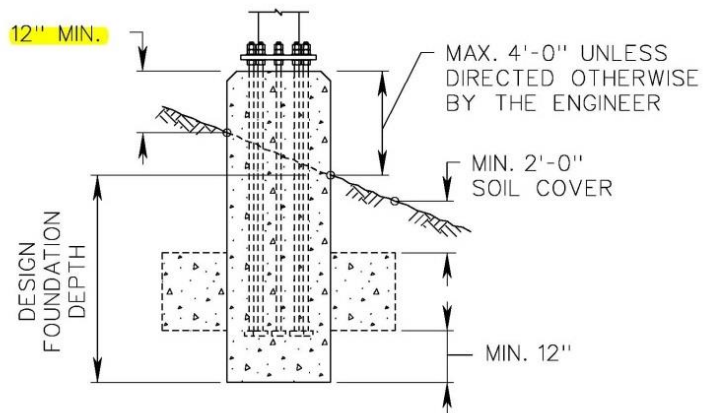
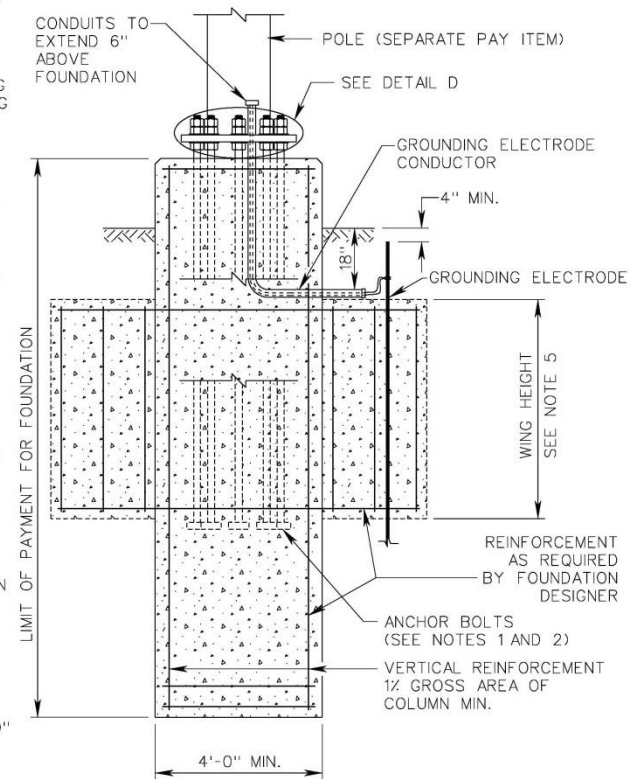
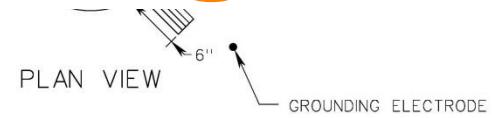
- **Special Provisions for nut tightening issued Feb. 21, 2013.**
- **Turn-of-nut method with torque verification required.**
- **UT test: After Installation**



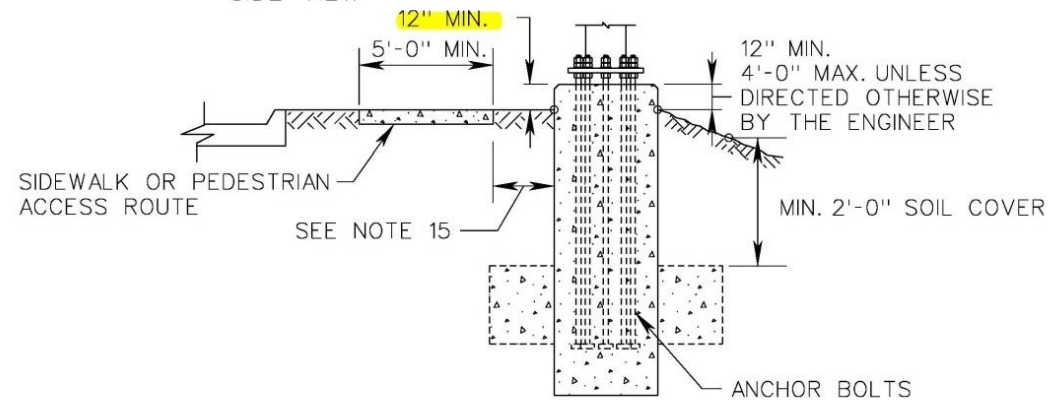
Road and Bridge Standards

NOTES:

1. ANCHOR BOLTS SHALL HAVE A RING OR NUTS AND WASHERS ON THE ENDS OF BOLTS EMBEDDED IN FOUNDATION.
2. ANCHOR BOLT LAYOUT SHALL BE CHECKED AGAINST LATEST APPROVED STRUCTURE DRAWINGS. A MINIMUM OF EIGHT 2" DIAMETER ANCHOR BOLTS ARE REQUIRED.
3. ALL CONDUITS AS SPECIFIED IN THE CONTRACT DOCUMENTS. IN ADDITION 1 - 1" MIN. CONDUIT REQUIRED FOR GROUNDING ELECTRODE CONDUCTOR. 2 - 2" PVC CONDUITS REQUIRED FOR FUTURE USE. NOTE THAT ADDITIONAL SPARE CONDUITS MAY BE REQUIRED BY THE CONTRACT DOCUMENTS.
4. IF NEEDED IN SLOPED CONDITIONS TO MAINTAIN POSITIVE DRAINAGE AROUND THE FOUNDATION AND TO PROVIDE THE CLEARANCES SHOWN IN DETAIL A, THE CONTRACTOR SHALL RE-GRADE AND ADD RETAINING CURB OR MATERIAL ON THE UP SLOPE WHEN APPROVED BY THE ENGINEER. RE-GRADING AND RETAINING CURB SHALL BE INCLUDED IN THE PRICE BID FOR FOUNDATION.
5. FOUNDATION SHALL BE DESIGNED FOR TORSION. WINGS MAY BE USED FOR TORSIONAL RESISTANCE IF REQUIRED.
6. ANCHOR BOLTS AND BOLT TEMPLATE SHALL BE FURNISHED WITH POLE. POLE SHALL BE CENTERED ON FOUNDATION.
7. EACH FOUNDATION SHALL BE PERMANENTLY MARKED TO INDICATE ALL SIDES FROM WHICH CONDUITS PASS. THIS MARK SHALL BE MADE WITH A TROWEL WHEN FINISHING THE CONCRETE AND SHALL BE 1/4" DEEP AND 4" TO 6" LONG. LOCATIONS OF EMPTY CONDUITS SHALL HAVE AN ADDITIONAL 2" LONG MARK MADE PERPENDICULAR TO AND CENTERED ON THIS MARKING.
8. GROUNDING BUSHINGS SHALL BE INSTALLED ON EACH END OF METAL CONDUITS.
9. EMPTY CONDUITS SHALL BE PLUGGED TO PREVENT MOISTURE AND RODENT ENTRY.
10. BELL ENDS SHALL BE INSTALLED ON EACH END OF PVC CONDUITS.
11. NO MORTAR, GROUT, OR CONCRETE SHALL BE PLACED BETWEEN BOTTOM OF BASE PLATE AND TOP OF FOUNDATION.
12. HEIGHT, WIDTH, DEPTH, AND REINFORCEMENT OF FOUNDATION SHALL BE AS REQUIRED BY FOUNDATION DESIGNER.
13. OPEN ENDS OF CONDUITS WITH CONDUCTORS INSTALLED SHALL BE SEALED WITH AN APPROVED OUTDOOR, WATERPROOF, SILICONE SEALANT. THE SEALANT SHALL NOT HAVE A DELETERIOUS EFFECT ON CABLE COVERINGS.
14. FOUNDATIONS SHALL NOT BE INSTALLED IN THE CENTER OF A DRAINAGE DITCH. IF APPROVED BY THE ENGINEER, FOUNDATIONS MAY BE INSTALLED IN THE SLOPE OF A DRAINAGE DITCH AT AN APPROVED HEIGHT ABOVE GRADE. THE FOUNDATION SHALL NOT BE PLACED IN THE FRONT SLOPE UNLESS THE ENGINEER DETERMINES THAT BACK SLOPE PLACEMENT IS NOT FEASIBLE.
15. THE EDGE OF THE FOUNDATION SHALL BE 1'-0" MIN. FROM THE EDGE OF A PEDESTRIAN PATH, OR 3'-0" MIN. FROM THE EDGE OF A SHARED USE PATH (SEE DETAIL B). IF APPROVED BY THE ENGINEER, FOUNDATIONS MAY BE PLACED IMMEDIATELY ADJACENT TO PEDESTRIAN PATH.
16. SPREAD FOOTING MAY BE USED IF APPROVED BY THE ENGINEER.



DETAIL A
FOUNDATION NOT IN
SIDEWALK DETAIL



DETAIL B
FOUNDATION ADJACENT
TO SIDEWALK DETAIL

- **I&IM-90 address issues related to foundation design.**
 - **Approved by FHWA and Traffic Engineering. Issued on Oct. 20, 2014.**

Geotechnical Design: The factor of safety shall be as follows:

MINIMUM FACTORS OF SAFETY			
	Drilled Shaft		Spread Footing
	Overhead Sign Structures and all other types of ancillary structures except for Mast arm traffic Signals	Mast arm traffic Signals	
Tip resistance/Bearing pressure	1.75	1.75	2.0
Torsion/Sliding/Skin Friction	2.0 ⁽¹⁾	1.3 ⁽¹⁾	1.2 ⁽²⁾
Overturning (Broms Method)	2.25	2.25	1.5

((The factors of safety shown above already account for the 1.33/1.40 group overload/overstress factor. No reduction shall be applied to the design loading used in the analysis.))

(1) Torsion Resistance shall be evaluated as specified by the AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (Version adopted by current I&IM-S&B-80) Section 10.8.3.5- Nominal Axial Compression of Single Drilled Shafts. A value of 1.0 shall be used in lieu of the resistance factors as shown in Table 10.5.5.2.4-1.

(2) Passive resistance shall be reduced by 50% to limit foundation movement.

Geotechnical Design: In capacity calculations for the foundation design of a drilled shaft, the soil resistance of the top 1.5 feet shall be neglected in the analysis for torsion/skin friction/tip resistance. The full length of the shaft from the ground surface to the tip may be used in overturning/horizontal deflection. The remainder of the shaft may be assumed to be fully effective in supporting applied loads.

Horizontal Deflection: In lieu of Broms method, COM624P or other commercially available software may be used to evaluate the overturning of shafts and to estimate shaft deflections. The total horizontal deflection shall be limited to 0.5 inches at the ground level and the tip of the pile deflection shall not exceed -0.1 inches. The loading used in the analysis shall not be reduced by the allowable overload/overstress factor.

Updates to I&IM-S&B-90

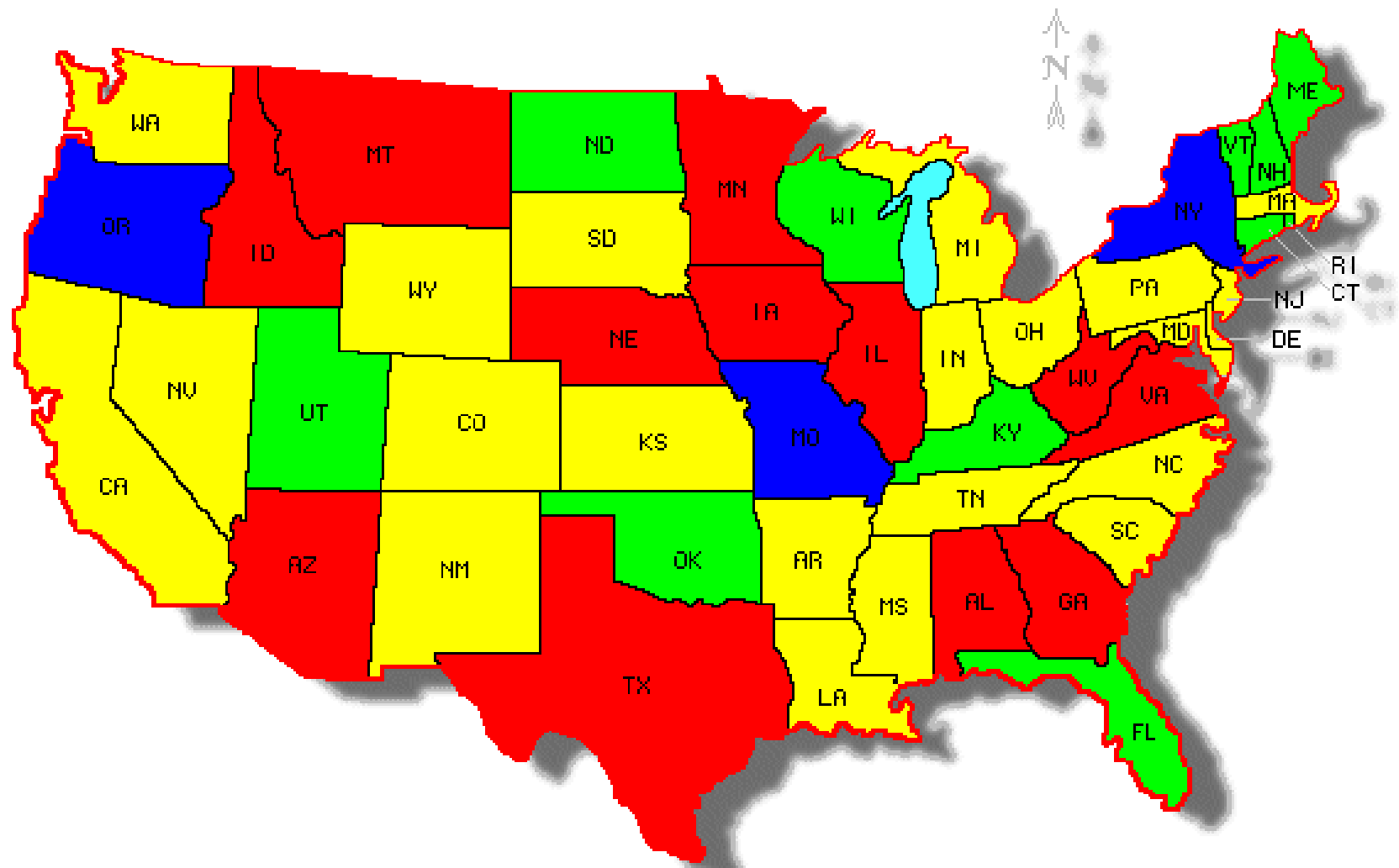
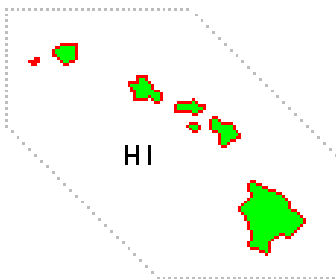
- Fatigue Loading



Updates to I&IM-S&B-90

AASHTO Specifications for Traffic Signals by State

- - 1994 Specs.
- - 2001 or 2009 Specs
- - 2013 Specs.
- - 1994 and other Specs



Updates to I&IM-S&B-90

- **Wind Loading per Appendix C: Alternate Method for Wind Pressures.**
- **Fatigue Importance Categories:**

Fatigue Importance Categories		
Signal Mast Arm	Greater than 75	Category I
Signal Mast Arm	50 feet to 75 feet	Category II
Signal Mast Arm	Less than 50 feet	No fatigue design required
Overhead Signal Structure	Greater than 190	Category I
Overhead Signal Structure	190 feet or less	Category II

- For signals with two arms or more, fatigue design based on longest arm for column.
- **AASHTO 11.8 Limit vertical deflection to 8”.**
- **No Changes Proposed to current Foundation language.**

Signal Brackets



Signal Brackets

- **Research Project underway at VCTIR.**
- **Add additional brackets to approved products list and updates to Specifications.**
- **Need to follow installation instructions from manufacturer.**
- **Sign Brackets variability in number required.**

LIGHT POLES

- Multiple issues found.
- Investigation underway.



LRFD

- **LRFD Sign Specification adopted by AASHTO at June 2014 meeting. Published ~ August 2015.**
 - **New wind model with no provisions to maintain any previous wind models.**
 - **Same Fatigue Provisions as 2013.**

Table 3.4-1--- Load Combinations and Load Factors

Load Combination Limit State	Description	Reference Articles	Permanent		Transient			Fatigue			
			Dead Components (DC)	Live Load (LL)	Wind (W)	Truck Gust (TrG)	Natural Wind Gust Vibration (NWG)	Vortex-Induced Vibration (VIV)	Combined Wind on High-level Towers	Galloping Induced Vibration (GVV)	
			Max/Min	Mean	Apply separately						
Strength I	Gravity	3.5, 3.6, and 3.7	1.25	1.6							
Extreme I	Wind	3.5, 3.8, 3.9	1.1/0.9		1.0 ^a						
Service I	Translation	10.4		1.0	1.0 ^b						
Service III	Crack control for Prestressed Concrete			1.0	1.00						
Fatigue I	Infinite-life	11.7	1.0			1.0	1.0	1.0	1.0	1.0	
Fatigue II	Evaluation	17.5	1.0			1.0	1.0	1.0	1.0	1.0	

a. Use Figures 3.8-1, 3.8-2, or 3.8-3 (for appropriate return period)
b. Use wind map 3.8-4 (service)

Table 3.8-1—Mean Recurrence Interval

Traffic Volume	Risk Category		
	Typical	High	Low
ADT < 100	300	1700	300
100 < ADT ≤ 1000	700	1700	300
1000 < ADT ≤ 10000	700	1700	300
ADT > 10000	1700	1700	300

Typical: Failure could cross travelway
High: Support failure could stop a lifeline travelway
Low: Support failure could not cross travelway
Roadside sign supports: use 300 years

- **Future NCHRP Study effective vibration dampeners.**

QUESTIONS??



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