

THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY

May 25, 2018

DESIGN BULLETIN No. 18-02

**SUBJECT: Structure Mounted Noise Abatement Wall (TL-5)**

The 2018 Illinois Tollway Structure Design Manual has been revised to include details and design guidelines for structure mounted noise abatement walls (NAW) to meet Test Level 5 (TL-5) in accordance with AASHTO Manual for Assessing Safety Hardware (MASH). Changes made are based on NCHRP Report 22-20(2), Sections 13 and 15 of AASHTO LRFD Bridge Design Specifications 8<sup>th</sup> Edition and recently conducted evaluation of the crash test performance of the Simulation Analysis of the Noise Abatement Wall (NAW) attached to Concrete Barrier according to AASHTO MASH / ASTM F2656 / ASTM F3016 at Texas Transportation Institute (TTI).

Details are applicable where NAW attached to structure is warranted including parapets mounted on moment slabs, approach slabs and bridge decks carrying Tollway traffic. Figures 1 and 2 show the moment slab and bridge deck, respectively. For approach slab base sheets M-RDY-408 and M-RDY-409, barrier with NAW shall be modified as per the barrier details shown in Figure 1.



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05/25/2018

Date

Changes to the following sections of Tollway Structure Design Manual shall apply:

1. Section 7.1.4  
Note 25. (Revise to) Horizontal design loads for retaining walls with moment slabs shall include the provisions of the AASHTO LRFD Bridge Design Specifications, Article 11.10.10.2 and Test Level 5 (TL-5 for 3 ft 6 in tall traffic railing) of 1.15 kips per foot and (TL-5 for 6 ft tall traffic railing) of 2.4 kips per foot applied at the top of fill supporting the Moment Slab.
2. Section 15.5.1  
Parapets and Barriers on Structures (End of Paragraph 1 add): For barrier where Noise Abatement Wall is attached to structure refer to sections 22.14, 23.2.2 and 23.5.1 of Illinois Tollway Structures Design Manual.
3. Section 22.12
  - a. (Replace this entire section with the following) The need for and design of the snow storage area shall be according to the latest version of the Illinois Tollway Roadway Design Criteria. When snow storage is required, the retaining wall and parapet shall move away from the edge of shoulder to create a place to store the snow in front of the parapet. If a noise abatement wall will be required at the location, the parapet with structure mounted noise abatement wall shall move away from the edge of shoulder and snow storage shall be accommodated in front of the parapet. Figure 1 - Structure Mounted Noise Abatement Wall on Moment Slab" with notes included provide the configuration and design of the parapet for attached noise abatement wall on a moment slab including snow storage as per the notes when needed.
4. Section 23.2.2  
Revise reference to Structure Mounted NAW shall be as per loads shown in the table below and Figures 1 and 2. Structure Mounted.
5. Section 23.5.1  
Waiver Alternative II: (Remove last Sentence and replace with the following) For this design scenario the bridge deck overhang shall be limited per the values listed on tables of Figure 2 – Structure Mounted Noise Abatement Wall on Bridge.

The goal during the implementation of these new details is to maintain as many current methods of construction and details as practical while achieving the strength requirements for TL-5 loading.

### **Design Criteria**

Design procedure is based on AASHTO LRFD Chapter 13. Design guides for exposed moment slab shall follow section 22.14 of the Illinois Tollway Structure Design Manual and as modified herein and in the figures. The following are modifications and design criteria used to develop details shown in Figures 1 and 2 attached.

- A moment slab includes both the horizontal slab and the 6 ft tall F-shape traffic railing
- Global Stability – Sliding and overturning stability of the moment slab shall be based on an Equivalent Static Load (ESL) applied to the top of the traffic parapet. For TL-5 parapet systems, the ESL shall be 106 kips.
- For sliding of the parapet-moment slab system:  $\phi$  = resistance factor = 0.8 (AASHTO Table 10.5.5.2.2-1) and  $Y$  = Load Factor = 1.0 (AASHTO Table 3.4.1-1)
- Friction angle of the soil on the moment slab interface taken equal to the friction angle of the soil which was assumed to be 30 degrees.
- For overturning of the parapet-moment slab system:  $\phi$  = Resistance Factor = 0.8 (AASHTO Table 10.5.5.2.2-1) and  $Y$  = Load Factor = 1.0 (AASHTO Table 3.4.1-1)
- Details shown in Figures 1 and 2 are based on 65 psf weight of wall system (panels, posts, connections including corbels) 18 ft above roadway surface in front of barrier. Walls greater than 18 ft shall be evaluated for stability and overhang design.
- Minimum length between moment slab expansion joints shall be 60ft for typical section shown in Figure 1.
- For 6 ft barrier, noise walls set back 10" minimum from the back of the concrete barrier may be considered outside the zone of intrusion, however it should still be designed to resist a collision force of 4.0 kips per Section 23.2.2 of the Structural Design Manual. For NAW mounted to the back of the barrier offset of less than 10", the force for NAW design shall be 30 kip per the table shown in Figures 1 and 2.
- To remove any degradation in noise barrier performance from sound diffracting through the gap, bottom of NAW shall be 4:1 ratio of the offset behind the barrier (e.g. if a 10" offset is used the bottom of NAW must be 40" below the top of barrier). Other means of filling the gap to eliminate overlap may be considered and is subject to the Tollway approval.
- For cast-in-place retaining walls without moment slab system, the barrier/NAW system shall be designed and detailed as per this design bulletin.

Design Loads shall be as follows:

Design Loads for TL-5 Barrier > 42in	
Rail Height, H (in.)	72
$F_t$ Transverse (kips)	260
$F_L$ Longitudinal (kips)	75
$F_v$ Vertical (kips)	80
$L_L$ and $L_t$ (ft)	10
$L_v$ (in)	40
$H_e$ (in)	52
$F_s$ (kips)	106
$W_{min}$ (ft)	12

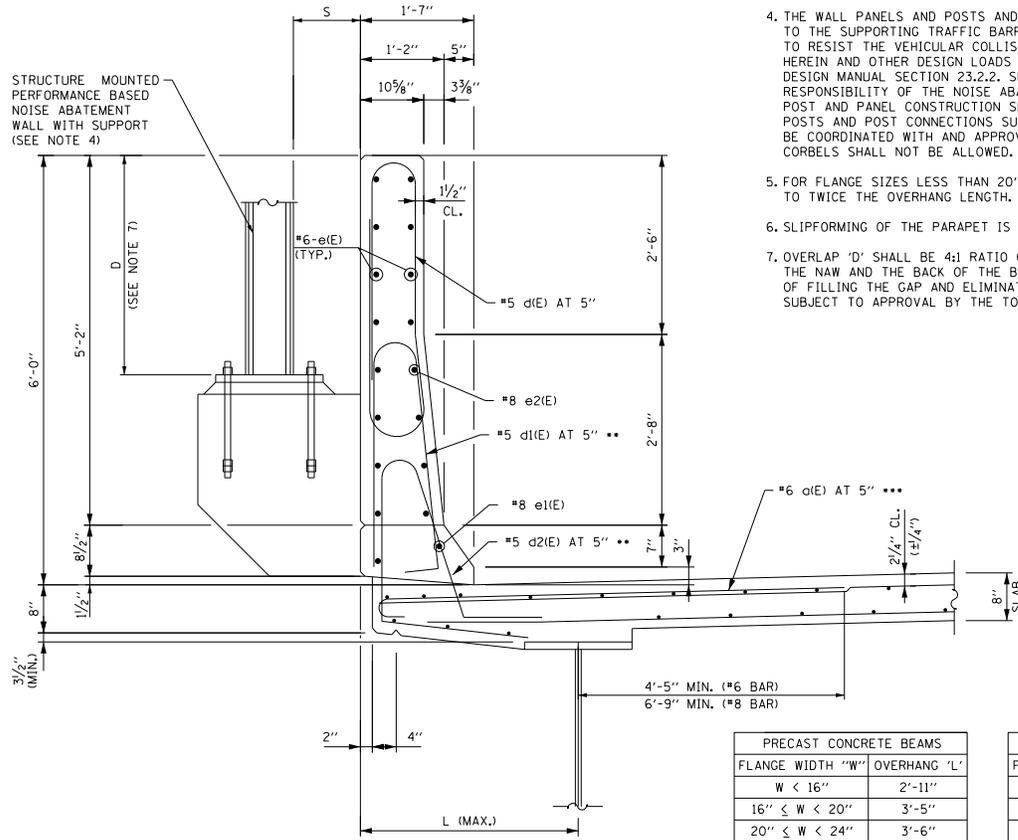
Where terms are defined as follows:

- H = Barrier Height (6ft)
- $F_t$  = Transverse force assumed to be acting at distance  $H_e$
- $F_L$  = Longitudinal friction force along the barrier
- $F_v$  = Vertical force of vehicle laying on top of the barrier
- $L_t$  = Longitudinal length of distribution of impact force  $F_t$
- $L_L$  = Longitudinal length of distribution of friction force  $F_L$
- $L_v$  = Longitudinal distribution of vertical force  $F_v$  on top of the barrier
- $H_e$  = Height of impact force applied to the barrier above pavement
- $F_s$  = Equivalent static load
- $W_{min}$  = Minimum width of the moment slab



NOTES:

1. TYPICAL DETAIL SHOWN IS FOR INTERIOR SECTIONS LOCATED MORE THAN 15FT FROM EXPANSION JOINTS. FOR END REGIONS MAKE MODIFICATIONS AS INDICATED HEREIN.
2. DETAILS IN THIS FIGURE ARE APPLICABLE WHERE NOISE ABATEMENT WALL IS WARRANTED FOR NEW STRUCTURES AND BRIDGE RECONSTRUCTION. DETAILS SHALL BE CONSIDERED FOR DECK REPLACEMENT OR SUPERSTRUCTURE WIDENING ON A CASE BY CASE BASIS WHERE FEASIBLE.
3. MAXIMUM NOISE WALL HEIGHT IS BASED ON 18FT ABOVE SURFACE OF SLAB IN FRONT OF THE BARRIER AND DEAD LOAD OF 65 PSF FOR THE NOISE WALL AND 0.5 KLF FOR THE NOISE WALL SUPPORT.
4. THE WALL PANELS AND POSTS AND THE POST CONNECTIONS TO THE SUPPORTING TRAFFIC BARRIER SHALL BE DESIGNED TO RESIST THE VEHICULAR COLLISION LOADS AS SPECIFIED HEREIN AND OTHER DESIGN LOADS AS PER TOLLWAY STRUCTURAL DESIGN MANUAL SECTION 23.2.2. SUCH DESIGN SHALL BE THE RESPONSIBILITY OF THE NOISE ABATEMENT WALL MANUFACTURER. POST AND PANEL CONSTRUCTION SHOWN, TYPE, SIZE, SPACING OF POSTS AND POST CONNECTIONS SUCH AS CORBELS/OTHERS SHALL BE COORDINATED WITH AND APPROVED BY THE TOLLWAY. CONTINUOUS CORBELS SHALL NOT BE ALLOWED.
5. FOR FLANGE SIZES LESS THAN 20", LIMIT THE ADJACENT BEAM SPACE TO TWICE THE OVERHANG LENGTH.
6. SLIPFORMING OF THE PARAPET IS NOT PERMITTED.
7. OVERLAP 'D' SHALL BE 4:1 RATIO OF THE GAP BETWEEN THE NAW AND THE BACK OF THE BARRIER. OTHER MEANS OF FILLING THE GAP AND ELIMINATE OVERLAP MAY BE USED, SUBJECT TO APPROVAL BY THE TOLLWAY.



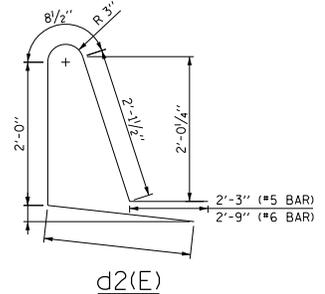
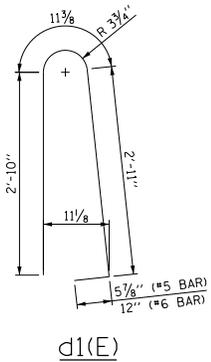
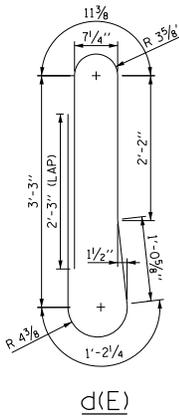
OFFSET 'S'	FORCE
S < 10"	30 KIP
10"	4 KIP

PRECAST CONCRETE BEAMS	
FLANGE WIDTH "W"	OVERHANG "L"
W < 16"	2'-11"
16" ≤ W < 20"	3'-5"
20" ≤ W < 24"	3'-6"
24" OR WIDER	3'-8"

STEEL BEAMS	
FLANGE WIDTH "W"	OVERHANG "L"
W < 18"	2'-11"
18" ≤ W < 24"	3'-4"
24" ≤ W < 30"	3'-6"
30" ≤ W < 36"	3'-7"
36" OR WIDER	3'-8"

• VEHICLE COLLISION FORCE IS THE LOAD APPLIED TO THE NOISEWALL AT THE HIGHEST POINT UP TO 14FT ABOVE SURFACE OF PAVEMENT IN FRONT OF THE BARRIER. FOR AN OFFSET LESS THAN 10", THE FULL 30 KIP FORCE SHALL BE APPLIED TO THE NAW. OFFSET 'S' WILL BE DETERMINED BY THE NOISE ABATEMENT WALL MANUFACTURER.

- WITHIN 15 FOOT OF AN EXPANSION JOINT USE #6 AT 5" SPACING.
- WITHIN 15 FOOT OF AN EXPANSION JOINT USE #8 AT 5" SPACING.



# STRUCTURE MOUNTED NOISE ABATEMENT WALL ON BRIDGE

FIGURE 2