



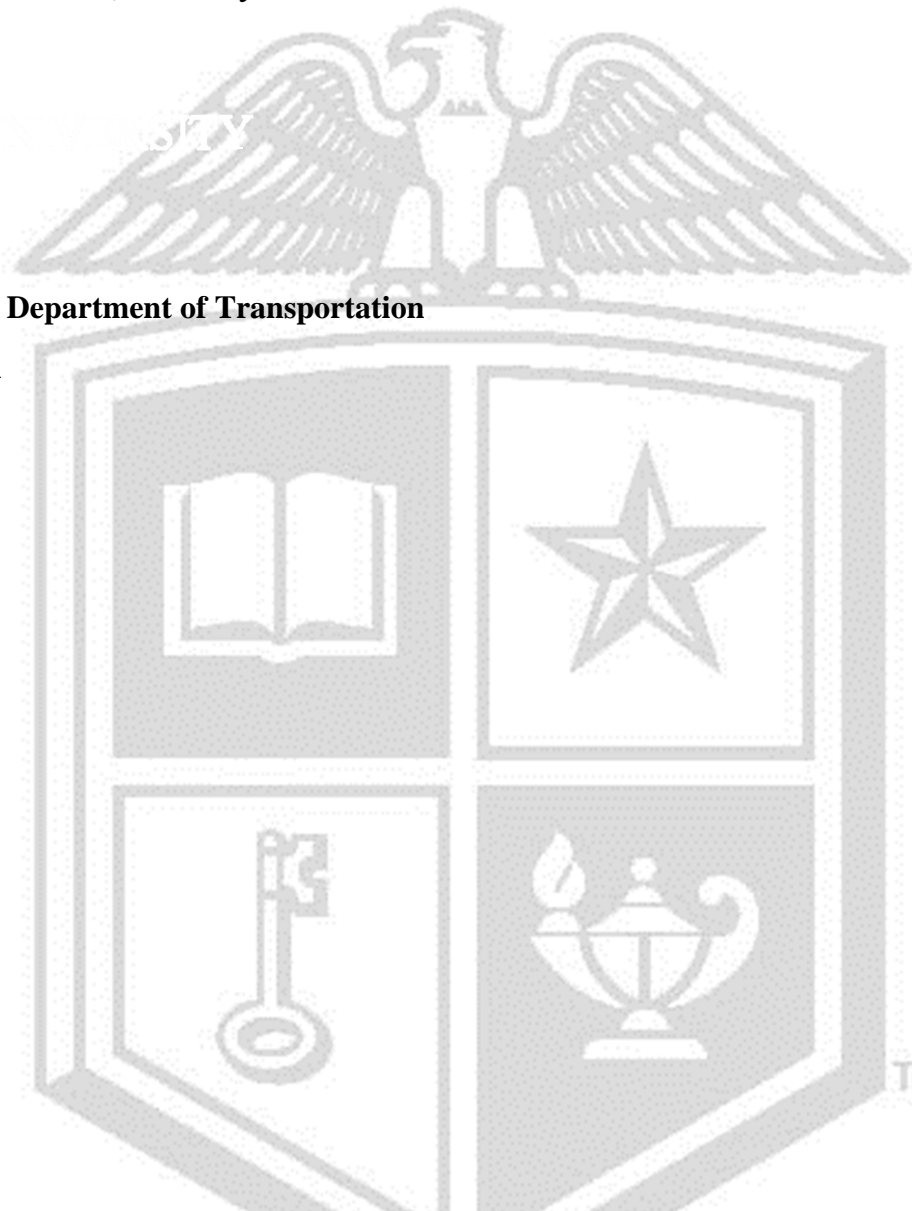
Texas Tech University
Multidisciplinary Research in Transportation

Field Guide for Reinforcement Reconfiguration Around Obstructions

William D. Lawson, Priyantha Jayawickrama, Timothy Wood

Performed in Cooperation with the Texas Department of Transportation
And the Federal Highway Administration

Research Project 0-6493
Research Product 0-6493-P1
<http://www.techmrt.ttu.edu/reports.php>



Notice

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Field Guide for Reinforcement Reconfiguration Around Obstructions

William D. Lawson

Priyantha Jayawickrama

Timothy Wood

Texas Tech Center for Multidisciplinary Research in Transportation

Research Project 0-6493

Research Product 0-6493-P1

TxDOT Research Project 0-6493

Pullout Resistance of Mechanically Stabilized Earth Reinforcements in Backfills Typically Used in Texas

Product P-1: Field Guide for Reinforcement Reconfiguration around Obstructions

PURPOSE: This product provides guidance for wall designers, wall suppliers, contractors and field inspectors concerning proper reconfiguration of earth reinforcements to circumvent obstructions encountered during construction of Mechanically Stabilized Earth (MSE) retaining walls. The guidelines presented in this document have been developed based on published MSE design standards (1, 2) and the findings from TxDOT research study 0-6493 that investigated the impact of alternative reinforcement configurations on the pullout resistance capacity of MSE reinforcements embedded in TxDOT Type A and Type B select backfill (3).

BACKGROUND: Conflicts between obstructions that are located behind the wall facing and earth reinforcement are a common problem encountered during MSE wall construction. Such obstructions may include foundations for bridge abutments, foundations for traffic sign structures and light poles, drainage inlets and storm sewers. These obstructions can be broadly classified into two categories: (1) vertical obstructions, and (2) horizontal obstructions. Drilled shafts and driven piles supporting bridge abutments and drainage inlets are examples of vertical obstructions. Drainage pipe that run along the length of the wall is an example of a horizontal obstruction. Obstructions located within reinforced fill often prevent the reinforcements from being placed in their proper configuration as shown on the construction drawings. Such potential conflicts should be identified during preliminary project planning stages so that appropriate modifications can be made by the wall designer of record. Whenever practical, obstructions should be moved away from reinforced fill to avoid the conflict. However, relocation of structures to avoid conflicts may not be possible in many situations. In these instances, appropriate alternative reinforcement layouts may be used to circumvent the obstructions found within the reinforced fill. Acceptable alternative reinforcement layouts vary with the type, size and location of the obstruction.

SCOPE: Several different strategies are used when modifying soil reinforcement layout to avoid obstructions (1). Strategies used to avoid conflict with vertical obstructions include the following: (a) providing the wall facing with additional connectors and then shifting the soil reinforcing laterally, (b) placing a structural frame around the obstruction and then attaching the frame to the wall facing on the front and the soil reinforcing on the back, (c) skewing strip type reinforcement at connection to the wall facing, (d) cutting transverse bars of the welded steel grid reinforcement and splaying longitudinal bars to avoid obstruction. The guidelines provided herein are applicable to strategies (c) and (d) only. Furthermore, this product does not deal with alternative reinforcement configurations to avoid horizontal obstructions.

Additional information regarding modification of soil reinforcement details to avoid obstructions can be found in the FHWA Publication No. FHWA-NHI-10-024 (1) and RECo Technical Bulletin MSE-3 (2).

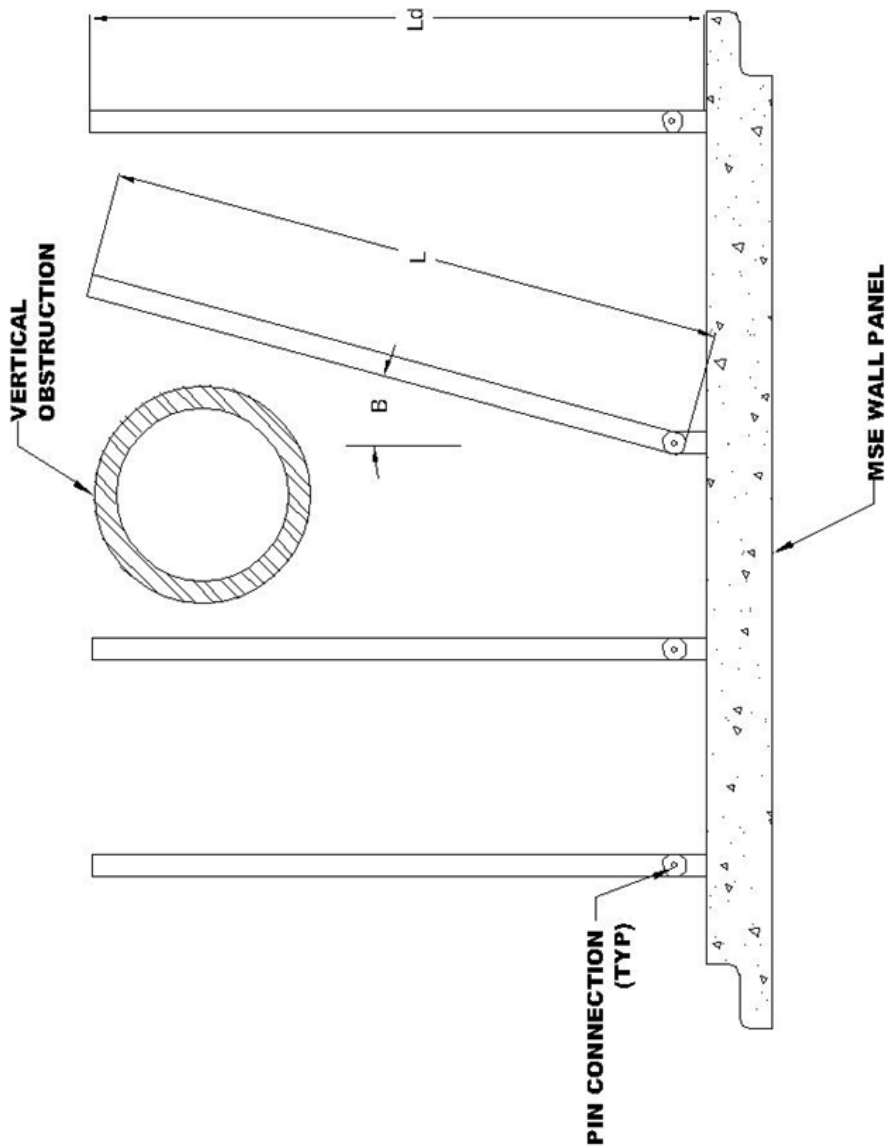
REINFORCEMENT RECONFIGURATION AROUND OBSTRUCTIONS

Skewing of Strip Type Reinforcement

Figures 1 and 2 illustrate skewing of reinforcement, a strategy that is commonly used to avoid vertical obstructions. This strategy is acceptable for use with ribbed strips or other types of reinforcements that are connected to the wall facing with a pin (bolted) connection. This type of connection allows rotation of the reinforcement without inducing additional stresses within the soil reinforcement.

The following guidelines were developed based on testing performed on ribbed strip reinforcement embedded in TxDOT Type A and Type B select backfill. These guidelines should be followed when skewing strip type reinforcement to avoid obstructions:

1. The reinforcement should be rotated (skewed) at the pinned connection;
2. The reinforcement should not be cut, twisted or bent to avoid the obstruction;
3. The skew angle, β , should not exceed 15-degrees;
4. Special care should be taken when compacting backfill in the vicinity of the obstruction to ensure that the specified level of compaction is achieved.



1. PIN CONNECTION ALLOWS THE REINFORCEMENT TO BE ROTATED
2. SKEW ANGLE SHALL NOT EXCEED 15 DEGREES
3. TAKE SPECIAL PRECAUTION TO ACHIEVE PROPER COMPACTION

**AVOID VERTICAL OBSTRUCTIONS:
SKEWING ONE RIBBED STRIP**

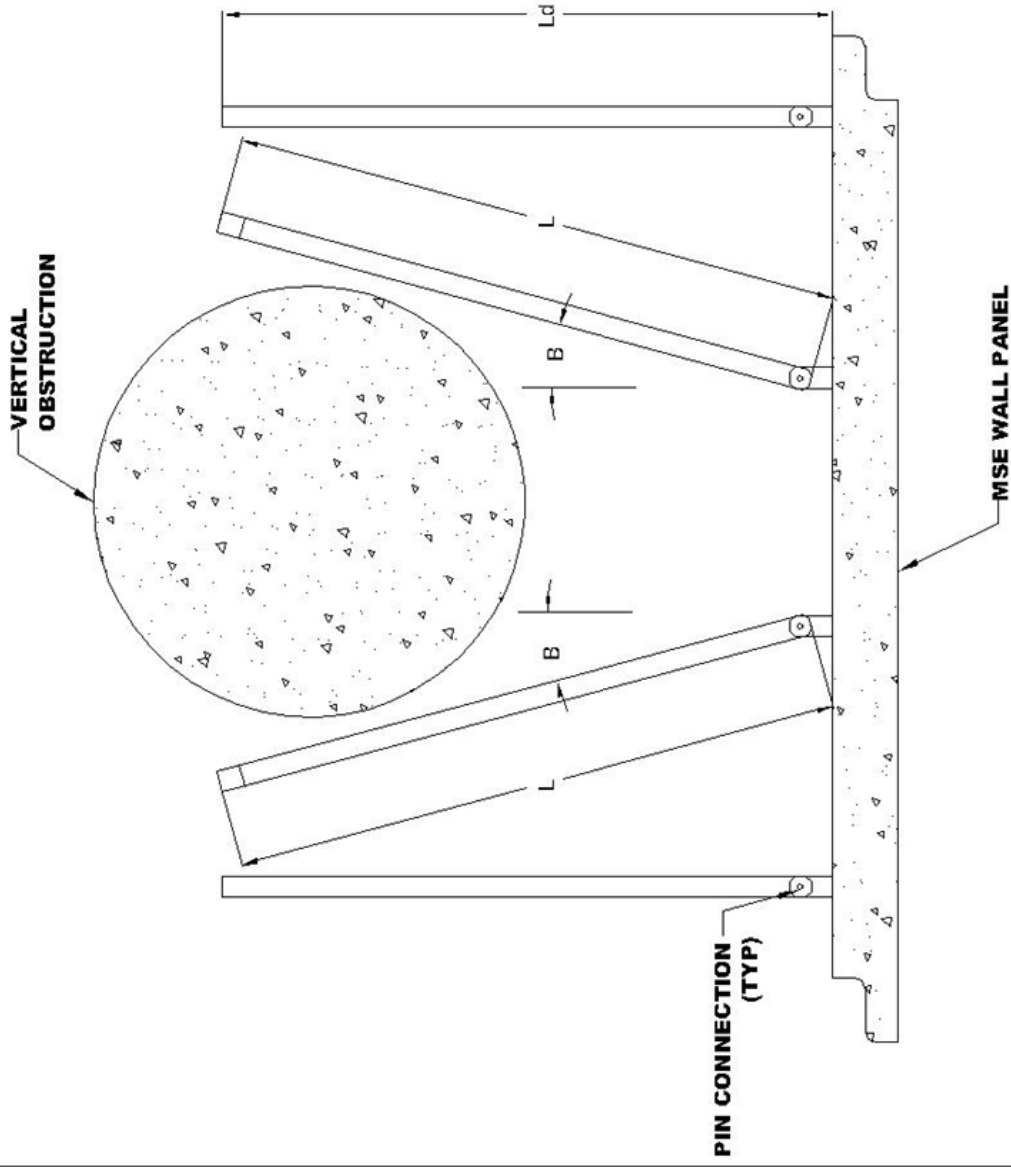
RIBBED STRIPS

NO SCALE

DATE: 08-20-2012

DRAWN BY: APJ CHECKED BY:PWJ

FIGURE 1



1. PIN CONNECTION ALLOWS THE REINFORCEMENT TO BE ROTATED
2. SKEW ANGLE SHALL NOT EXCEED 15 DEGREES
3. TAKE SPECIAL PRECAUTION TO ACHIEVE PROPER COMPACTION

**AVOID VERTICAL OBSTRUCTIONS:
SKEWING TWO OR MORE RIBBED STRIPS**

RIBBED STRIPS

NO SCALE

DATE: 08-20-2012

DRAWN BY: APJ CHECKED BY:PWJ

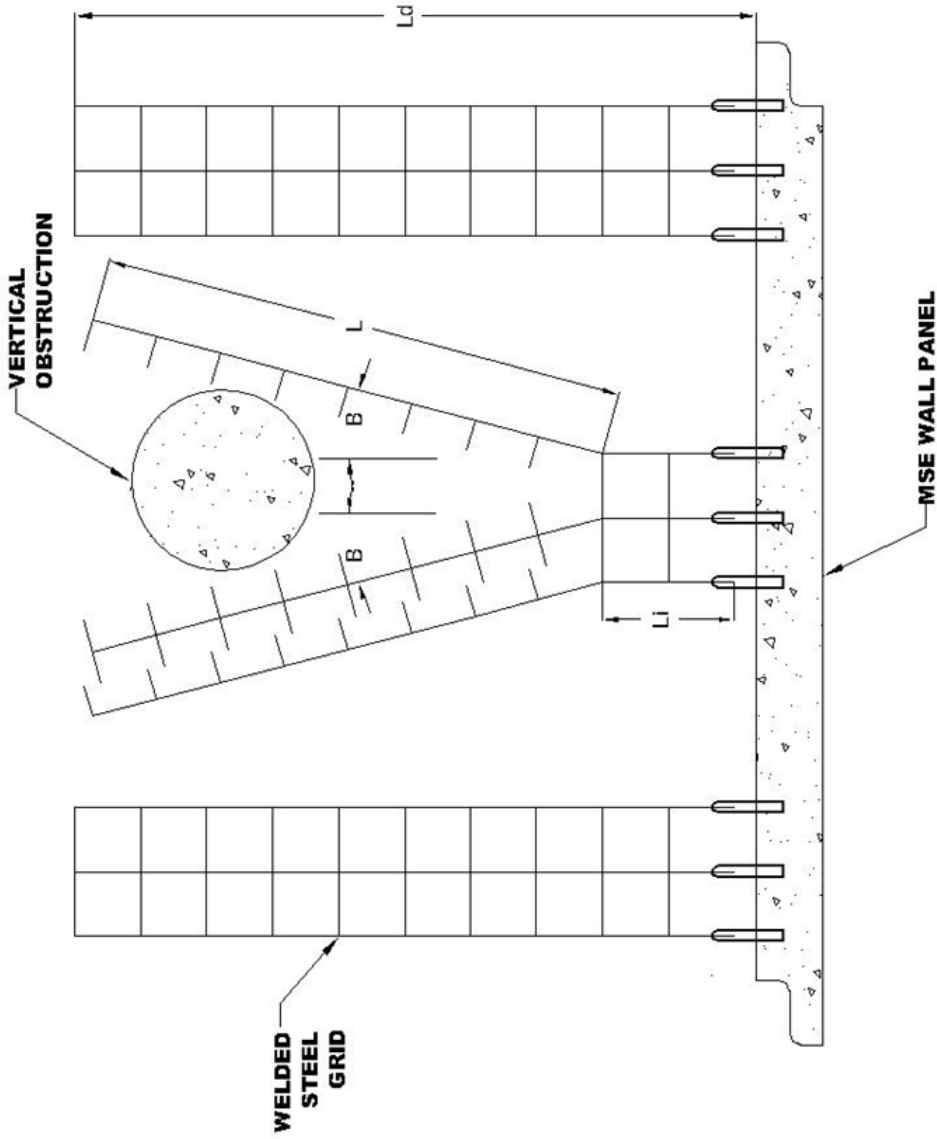
FIGURE 2

Cutting-and-Splaying of Grid Type Reinforcement

Figure 3 illustrates cutting-and-splaying of welded grid reinforcement. When this strategy is used, the transverse bars of the grid are cut in the middle allowing the longitudinal bars to be separated. Then the longitudinal bars are splayed, or bent, away from the obstruction as shown in the figure.

The following guidelines were developed based on testing performed on welded steel grid reinforcement embedded in TxDOT Type A and Type B select backfill. These guidelines should be followed when cutting-and-splaying grid type reinforcement to avoid obstructions:

1. Only transverse bars should be cut when using this approach; Cutting longitudinal bars is not permitted;
2. Cut transverse bar segments should remain attached to the longitudinal bars;
3. Splaying should originate at least two transverse bars from the wall face;
4. Splay angles (β) should not exceed 30-deg;
5. Increase the length, L of the reinforcement so that the projected length of the reinforcement normal to the wall panel will be same as the design length, L_D ; In other words, the splayed reinforcement should reach the limit of the reinforced soil volume;
6. Longitudinal bars should be bent smoothly to achieve the minimum splay angle necessary;
7. Use of heat to facilitate splaying of the longitudinal bars is not allowed;
8. Splayed longitudinal bars should be inspected to ensure that there is no damage to the galvanized coating due to bending; Any damage observed during field installation should be promptly repaired; (4)
9. Special care should be taken when compacting backfill in the vicinity of the obstruction to ensure that the specified level of compaction is achieved.



1. CUT TRANSVERSE BARS; NEVER CUT LONGITUDINAL BARS;
2. TRANSVERSE BARS THAT ARE SEVERED SHOULD REMAIN ATTACHED TO LONGITUDINAL BARS
3. SPLAY THE LONGITUDINAL BARS TO AVOID OBSTRUCTION AS SHOWN
4. THE SPLAY ANGLE SHOULD NOT EXCEED 30-DEG; SPLAYING SHOULD BE ACHIEVED WITHOUT HEATING THE BAR
5. INSPECT THE REINFORCEMENT TO ENSURE THAT THERE IS NO DAMAGE TO THE GALVANIZED COATING; EXPOSED STEEL SHOULD BE COATED WITH COLD GALVANIZING
6. PROVIDE EXTRA LENGTH SO THAT PROJECTED LENGTH IN THE DIRECTION NORMAL TO THE WALL PANEL WILL BE SAME AS THE DESIGN LENGTH; $L_d = L_i + L / \cos(B)$
7. TAKE SPECIAL PRECAUTION TO ACHIEVE SAME LEVEL OF COMPACTION
8. MINIMIZE BENDING OF CUT TRANSVERSE BAR SEGMENTS

AVOID VERTICAL OBSTRUCTIONS: CUT AND SPLAY WELDED STEEL GRIDS

NO SCALE DATE: 08-20-2012

SPLAYED GRID

DRAWN BY: APJ CHECKED BY:PWJ

FIGURE 3

REFERENCES

1. FHWA. *Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I*, FHWA NHI-10-024-Vol I, National Highway Institute, Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., November 2009.
2. Technical Bulletin: MSE-3, *Design of MSE Walls at Pile Supported Abutments*, The Reinforced Earth Company, Vienna, Virginia, August 1992.
3. Jayawickrama, P.W., J.G. Surles, T.A. Wood, and W.D. Lawson, “Pullout Resistance of MSE Reinforcements in Backfills Typically Used in Texas, Volume I: Research Report,” Final Research Report (draft), FHWA/TX-12/0-6493-R1, October 2012.
4. ASTM A780M-09: *Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings*, ASTM International, Annual Book of Standards Volume 01.06, 2012.



TEXAS TECH UNIVERSITY

Multidisciplinary Research in Transportation

Texas Tech University Lubbock, TX 79409

P. 806.742.3503 F 806.742.4168