RETAINING WALL DESIGN AND CONSTRUCITON ISSUES

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TxDOT Bridge Division

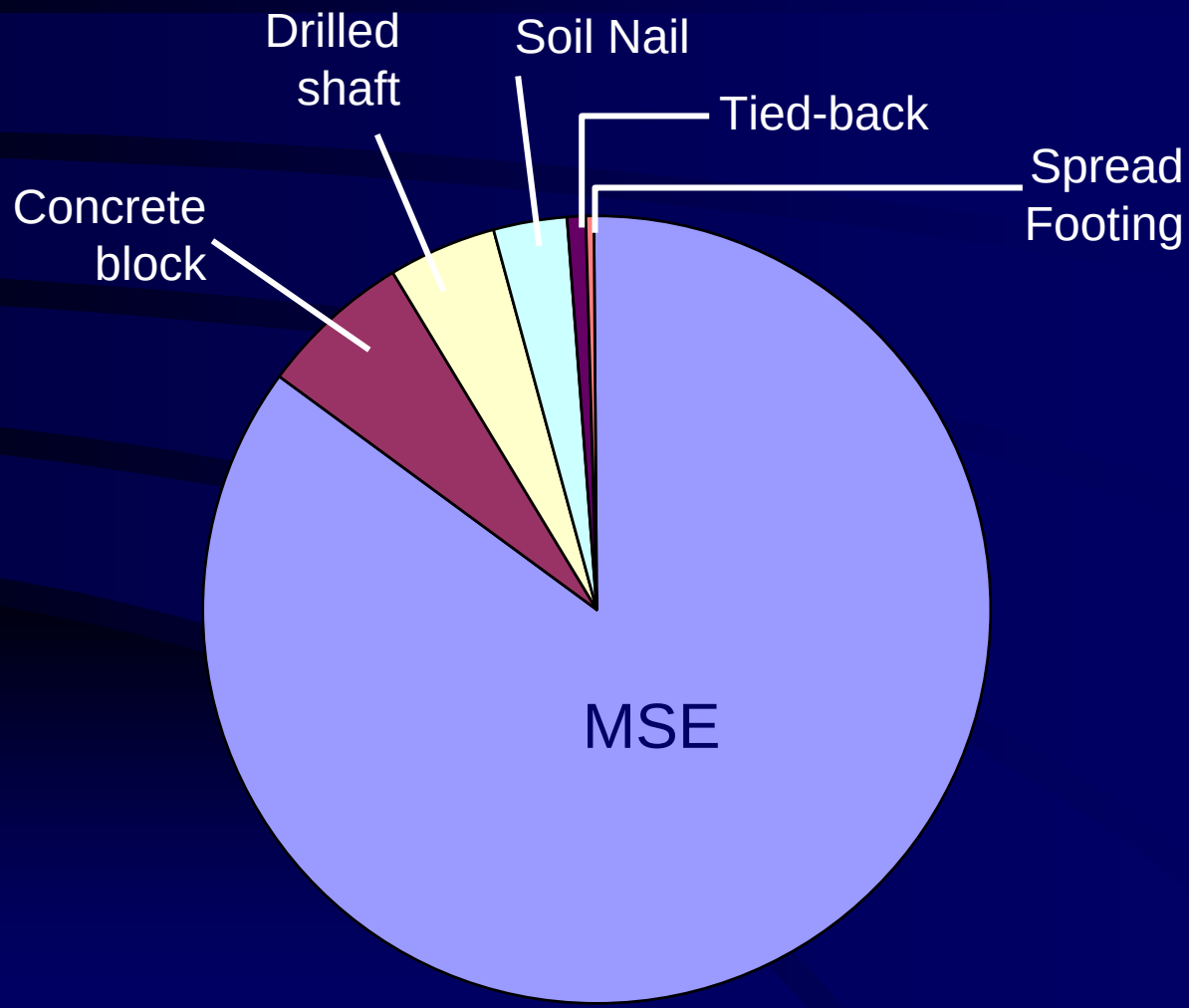
Wall Usage by TxDOT

(August 1, 2006 through June 20, 2007)

Wall Type	Area (ft^2)	%	$ per ft^2
MSE	2,000,000	85.1	35.00
Concrete block (no r/f)	150,000	6.4	26.00
Cantilever drilled shaft	100,000	4.3	70.00
Soil nailed	70,000	3.0	65.00
Tied-back	20,000	0.8	95.00
Spread footing	10,000	0.4	85.00

Wall Usage by TxDOT

(August 1, 2006 through June 20, 2007)

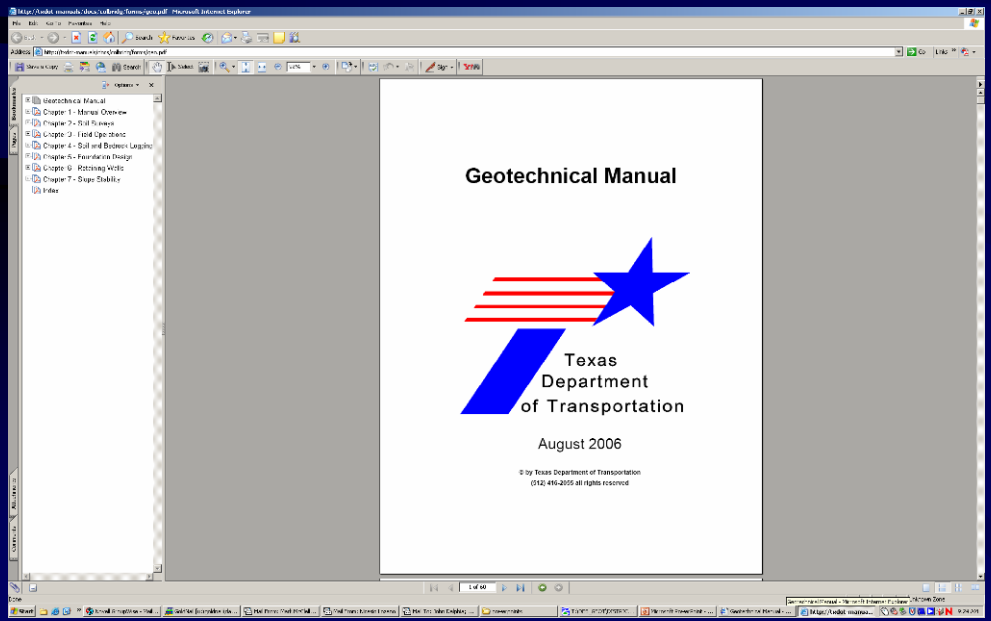


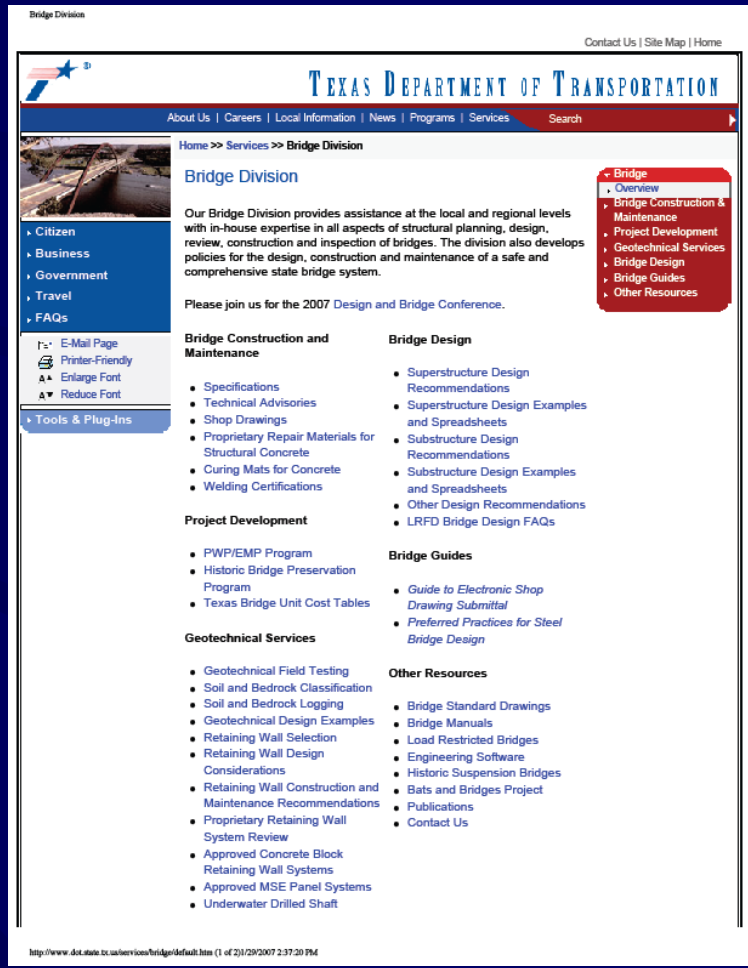
MSE WALLS

- Wall Design Considerations
- Backfill Selection and Testing
- Shop Drawings
- Wall Construction
- Other Considerations

System Design/Selection

- Responsibility
- Geometry
- Soil Characteristics





Responsibility

The Project Engineer (Designer of Record) must ensure that the retaining wall system selected for a given location is appropriate.

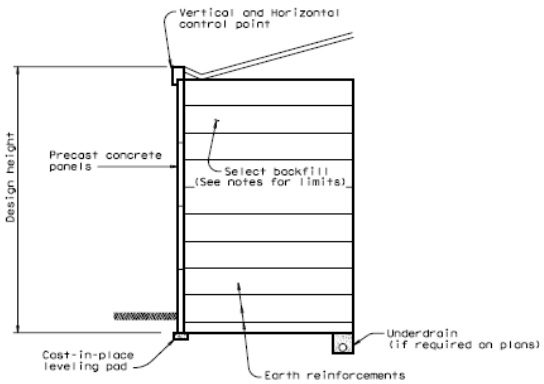
Geometry

- Fill vs. Cut
- Requirements for additional excavation and shoring
- Placement of walls on slopes

Soil Characteristics

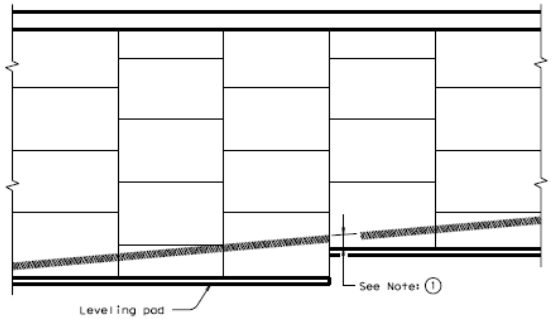
- Stability of every wall must be evaluated
- Short-term and Long-term conditions (make sure that the soil strengths used in analysis are valid for the given soil profile)
- General Analysis vs. Detailed Analysis

MSE WALL STANDARD



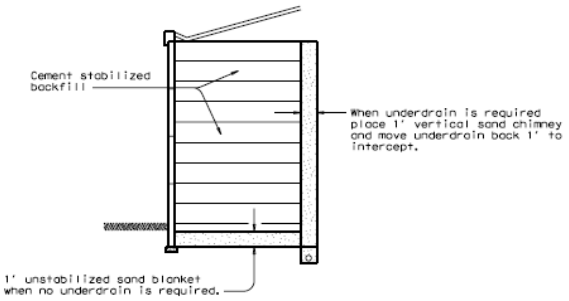
TYPICAL SECTION

(Wall at bottom of slope)



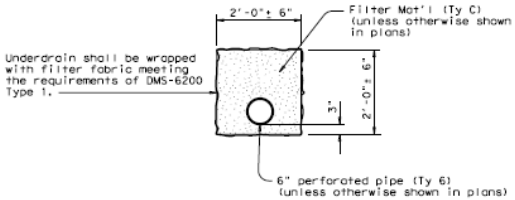
ELEVATION

1 NOTE: Unless noted elsewhere in the plans, 1' minimum cover shall be provided from the top of leveling pad to finish grade.



SPECIAL DRAINAGE PROVISIONS

(For use when cement stabilized backfill is used)



UNDERDRAIN DETAIL

MAP OF TEXAS EMBLEM

Map of Texas emblem shall be formed into a wall panel next to each bridge abutment. The exact location of each emblem shall be approved by the Engineer. The cost of forming the emblems will not be paid for directly, but shall be incidental to the Item "Retaining Wall".

The map of Texas shall be inset a minimum of ¾" into the face of the panel, and shall receive a smooth finish. The inset area shall be finished in a contrasting color as approved by the Engineer.

DESIGN PARAMETERS:

Design of retaining walls shall be based on the following design parameters:

Random Backfill (Embankment of Existing Soils)	unit weight = 125 pcf Ø = 30° c = 0 psf
Select Backfill	unit weight = 125 pcf Ø = 34° c = 0 psf
Cement Stabilized Select Backfill	unit weight = 125 pcf Ø = 45° c = 0 psf

Stress in steel and concrete shall be in accordance with current AASHTO Standard and Interim Specifications.

The minimum length of earth reinforcements shall be 8'-0".

STABILITY CRITERIA:

Factor of safety in sliding along the base of the structure shall be greater than or equal to 1.5.

Factor of safety in overturning shall be greater than or equal to 2.0.

The base pressure resultant shall fall within the middle third of the retaining wall.

The factor of safety against pullout of the earth reinforcements shall be greater than or equal to 1.5 at each level. Pullout resistance shall be determined from test data evaluated at ⅛ inch strain.

CORROSION CRITERIA:

The earth reinforcement elements shall be designed to have a corrosion resistance - durability to ensure a minimum design life of 75 years. Maximum loss per side due to corrosion shall be computed by assuming a uniform loss model based on the following

Zinc corrosion rate (First 2 years) - 15 µm/yr.
Zinc corrosion rate (subsequent years) - 4 µm/yr.
Carbon steel corrosion rate - 12 µm/yr.

All stress and pullout calculations shall be done on the calculated earth reinforcement section remaining after 75 years.

GENERAL NOTES:

Section and elevation shown is for informational purposes only. Specific geometry is to be determined based on wall layouts and other plan information.

The select backfill specified for use within the mechanically stabilized earth volume shall extend horizontally from the back of the panels to the end of the earth reinforcements. The select backfill shall extend vertically from the top of the leveling pad or 4" below the lowest earth reinforcement, whichever is lower, to the top of panels.

The uppermost earth reinforcements shall be no more than 3.0' below the top of wall.

The lowest level of earth reinforcements shall be no more than 2.0' above the top of the leveling pad.

Minimum wire size for earth reinforcements shall be W7.0. If different longitudinal and cross wires are used in an earth reinforcement mesh, the smaller wire shall have at least 50% of the cross sectional area of the larger wire.

Standard precast concrete panels shall have a maximum height of 6', and a maximum surface area of 50 sq ft. Minimum panel thickness shall be 5". Panels shall be arranged to provide offset horizontal joints.

An open joint shall be provided around the perimeter of the concrete panels. The nominal joint opening shall be between ⅜" and ¾". The joint configuration shall be such that the filter fabric or pad materials are not exposed at the wall face.

A one-piece corner panel shall be provided for wall angle changes of greater than 30 degrees. Butting of chamfered panels will be allowed for angle changes of 30 degrees or less.

Concrete coping shall be provided along the top of wall, at the vertical steps at bridge backwalls, and at other vertical steps along the top of wall. The joints between all coping segments shall be sealed to prevent infiltration of water into the retaining wall backfill. Sealing shall be in accordance with the Item "Joint Sealants and Fillers", using Class 4 joint sealant.

FILE: PATH:

LEVELS DISPLAYED

Texas Department of Transportation
Bridge Division

MECHANICALLY STABILIZED EARTH RETAINING WALL

RW(MSE)

FILE: rwstde01.dgn	DN: TxDOT	CK: TxDOT	DW: GHO	CK: MFM			
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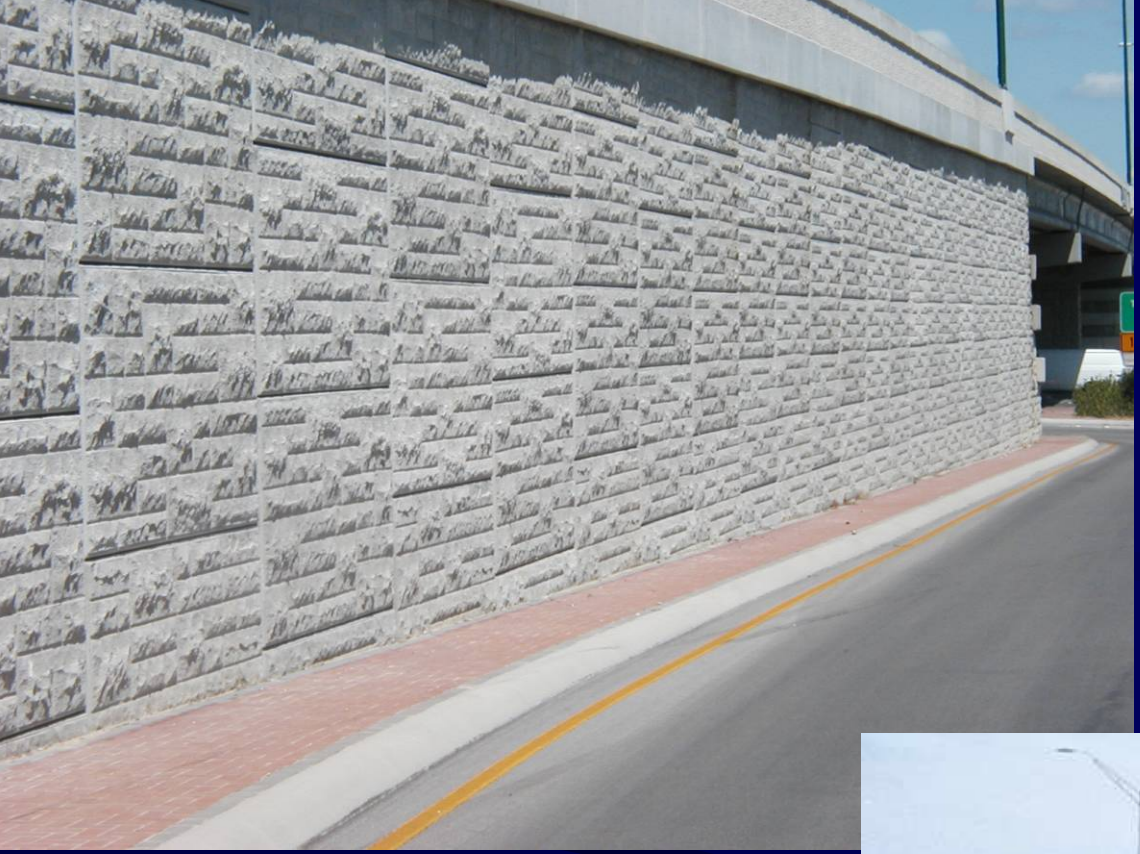
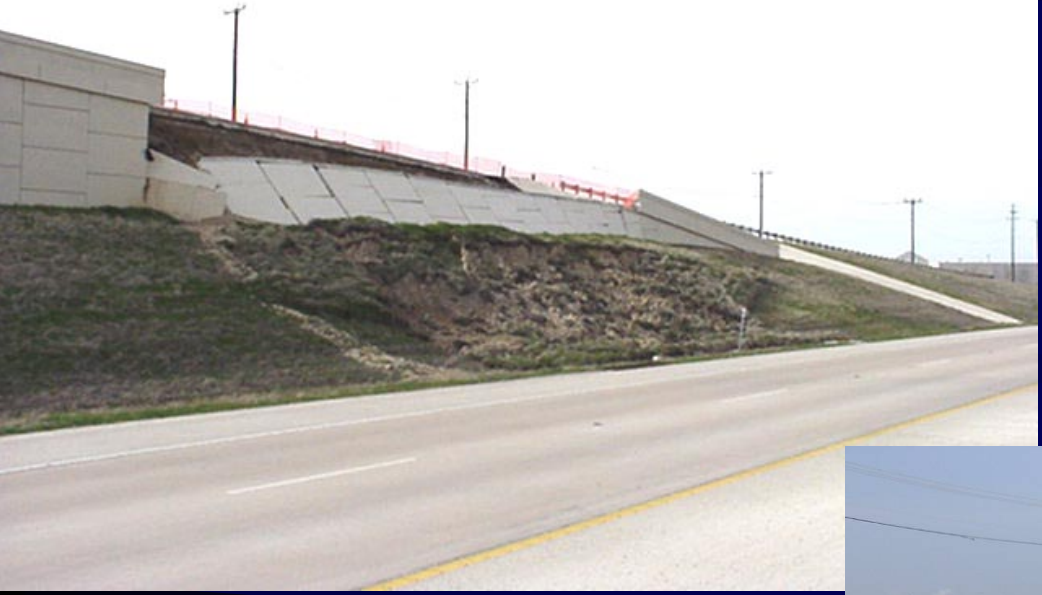
REVISIONS							
	COUNTY		CONTROL	SECT	JOB	HIGHWAY	

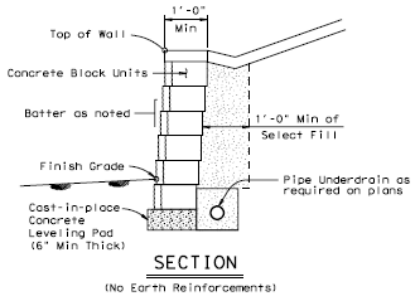
MSE PANEL FINISH



MSE WALLS
BUILT ON SLOPES

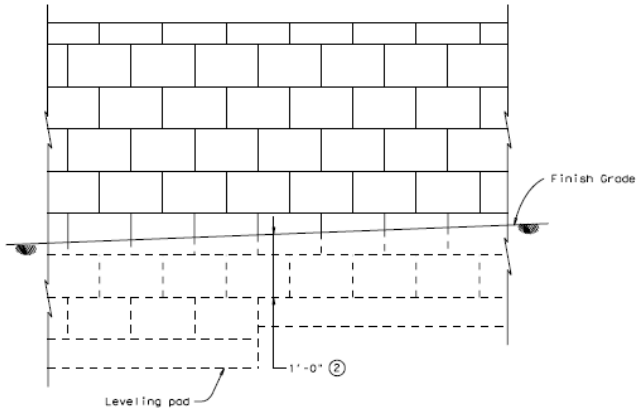


CB WALL STANDARD

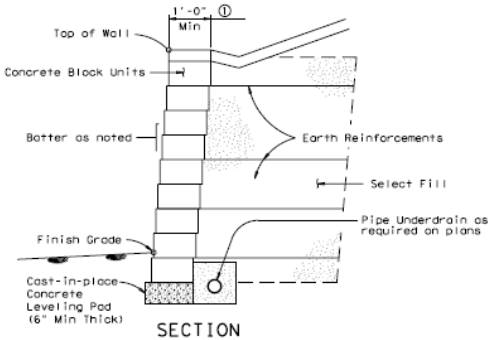


SECTION

(No Earth Reinforcements)

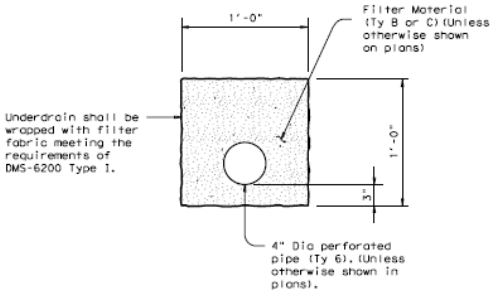


TYPICAL ELEVATION



SECTION

(With Earth Reinforcements)



UNDERDRAIN DETAIL

① For systems utilizing continuous structural pins passing thru a minimum of 3 block layers, the minimum block depth shall be 8". The maximum vertical spacing of primary reinforcement on these systems shall be 24", and intermediate reinforcement will not be required.

② Unless noted elsewhere in the plans, 1'-0" minimum cover shall be provided from the top of leveling pad to finish grade.

③ For walls which are designated as landscape walls and are less than 6' tall, the following modifications to the design criteria will be allowed:

Factor of safety in sliding > 1.2.
Factor of safety in overturning > 1.5.
Connection strength factor of safety of 1.0 at ¾" strain.
Minimum earth reinforcement length of 4'.

The above modified criteria does not apply to walls over 6' tall regardless of designation.

EARTH REINFORCEMENTS:

Walls may be constructed without earth reinforcements if all stability criteria are met with the blocks alone. If all stability criteria are not satisfied, earth reinforcements shall be provided.

The long term design strength (LTDS) of earth reinforcement shall be calculated in accordance with current AASHTO Standard and Interim Specifications.

Soil-geogrid pullout coefficient values shall be determined in accordance with Geosynthetics Research Institute (GRI) Method GG-5, "Guidelines for Evaluating Geogrid Pullout".

For the combination of concrete block and geogrid chosen, connection strength data shall be provided. The allowable connection load shall be limited to the connection strength developed at ¾" displacement, divided by a 1.5 safety factor. ③

For internal stability calculations, the failure plane will be assumed to originate at the back of the concrete blocks.

The factor of safety against pullout of the earth reinforcements shall be determined from test data evaluated at ¾" strain.

The maximum vertical spacing of primary earth reinforcement layers shall be 40 inches. ①

The minimum length of primary earth reinforcements shall be 8 feet, measured from the front of the blocks. ③

A layer of intermediate reinforcement shall be provided between primary reinforcements when the spacing between primary layers exceeds twice the horizontal depth of the concrete block unit. Intermediate reinforcement shall have a minimum length of 4 feet, and shall provide local stability for the concrete block units. ①

STABILITY CRITERIA:

Factor of safety in sliding along the base of the structure shall be greater than or equal to 1.5. ③

Factor of safety in overturning shall be greater than or equal to 2.0. ③

The base pressure resultant shall fall within the middle third of the retaining wall.

DESIGN PARAMETERS:

Structure shall be based on the following design parameters:

Random Backfill: Unit weight = 120 pcf.
(Embankment or Existing Soils) ø = 30° c = 0 psf
Select Backfill: Unit weight = 120 pcf
ø = 34° c = 0 psf

GENERAL NOTES:

Sections and Typical Elevation shown are for informational purposes only. Specific geometry is to be determined based on wall layouts and other plan information.

Unless otherwise shown in the plans, wall batter shall be a maximum of 3" per foot. Blocks shall be placed horizontally, and a positive means of obtaining batter such as pins, keyways, or concrete lips shall be provided.

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Bridge Division

CONCRETE BLOCK
RETAINING WALL

RW(CB)

FILE: rwside02.dgn	DN: TxDOT	CK: TxDOT	DW: GHD	CK: MFM
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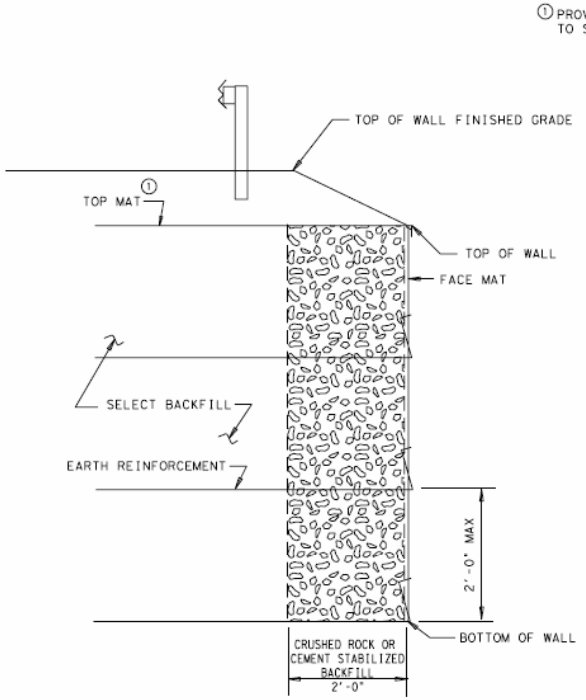
FILE: PATH:

CELLS DISPLAYED

Concrete Block Walls

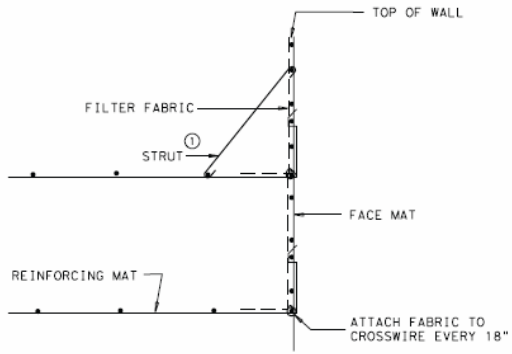
CB Walls

TEW WALL STANDARD



TYPICAL SECTION

(SHOWING TOP MAT OPTION)



DETAIL OF WALL FACE

(SHOWING STRUT OPTION)

EARTH REINFORCEMENTS:

The maximum vertical spacing of earth reinforcements shall be 24 inches.

The minimum length of earth reinforcements shall be 6 feet for walls 6 feet and shorter, and 8 feet for walls over 6 feet tall.

Minimum wire size for welded wire earth reinforcements shall be W4.5. Longitudinal wire spacing shall not exceed 12 inches. Transverse wire spacing shall not exceed 24 inches.

Earth reinforcement allowable stresses and pullout shall be calculated with current AASHTO Standard and Interim Specifications.

Factor of safety in pullout of the earth reinforcements shall be greater than 1.5 at each reinforcement level.

WALL FACE:

Minimum wire size for welded wire material used for all facing shall be W4.5. Spacing of the wire shall not exceed 6 inches in either the horizontal or vertical direction. The facing shall be designed to maintain a vertical position during wall backfilling. This may be accomplished with wire struts, external bracing, or other means which provide acceptable performance. If the face does not remain vertical during wall backfilling, work shall be stopped until the system is modified to meet this requirement.

Angled struts or a top mat shall be provided to stabilize the top basket face. Strut spacing shall not exceed 24 inches.

STABILITY CRITERIA:

Factor of safety in sliding along the base of the structure shall be greater than or equal to 1.5.

Factor of safety in overturning shall be greater than or equal to 2.0.

The base pressure resultant shall fall within the middle third of the retaining wall.

DESIGN PARAMETERS:

Structure shall be based on the following design parameters:

Random Backfill: Unit weight = 120 pcf.
(Embankment or Existing Soils) ϕ = 30° c = 0 psf
Select Backfill: Unit weight = 120 pcf
ϕ = 30° c = 0 psf

GENERAL NOTES:

Sections shown are for informational purposes only. Specific geometry is to be determined based on wall layouts and other plan information.

SPECIAL NOTE - FACE CONSTRUCTION

When constructing wire faced walls, it is critical that the area immediately behind the face mat be completely filled. Failure to fill and compact this area will result in bulging of the face mats and settlement of the top of wall. The filter fabric shall closely follow the contours of the face unit, with particular attention paid to the lower corner of the basket. The fabric shall be pulled into the corner and attached to the basket with hog rings or tie wire. The coarse rock or cement stabilized backfill in the two foot zone behind the face shall extend completely to the top of the face mat. Particular care shall be taken not to leave a gap or void below the next layer of earth reinforcement.

Texas Department of Transportation
Bridge Division

TEMPORARY EARTH RETAINING WALL

RW(TEW)

FILE: rwstde04.dgn	DN: TxDOT	CK: TxDOT	DW: GHO	CK: MFM
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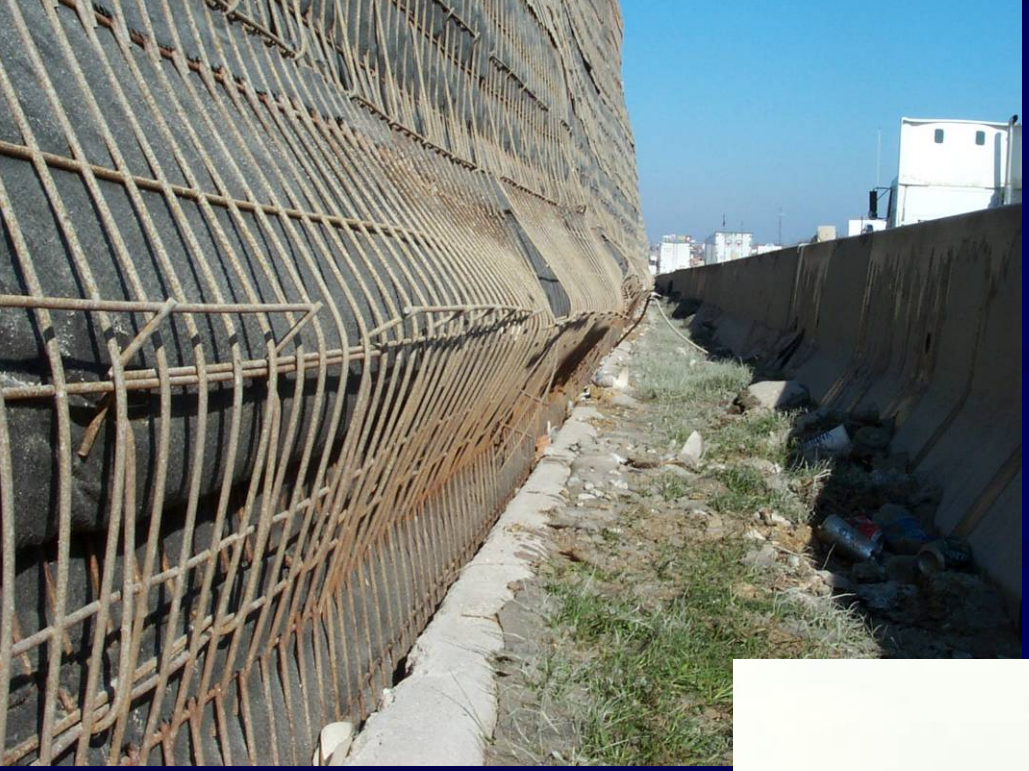
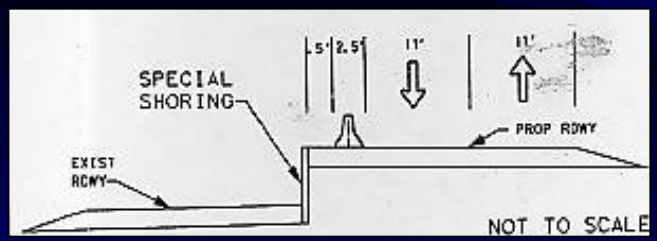
REVISIONS 5-06 : General Notes	COUNTY	CONTROL	SECT	JOB	HIGHWAY

LEVELS DISPLAYED | PATH:

TEW WALL

Default Design Life = 3 years





TEW WALL

TEW WALL

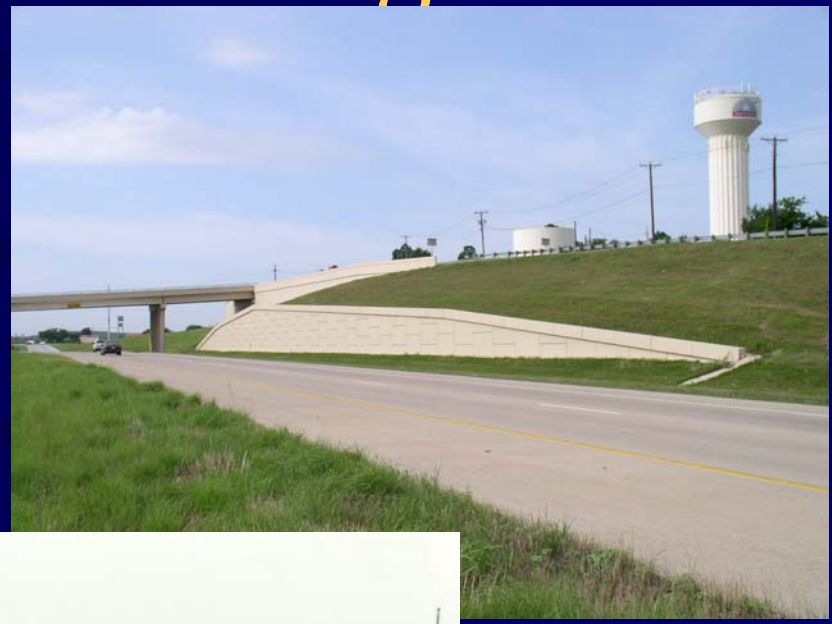
Dissimilar Metals in Reinforced Zone

TEW WALL

Design Life>3 years or TEW/MSE reinforced zones are coincident

TEMPORARY MSE WALL TIME OF SERVICE EXCEEDED EXPECTED DESIGN LIFE

MSE Shop Drawings



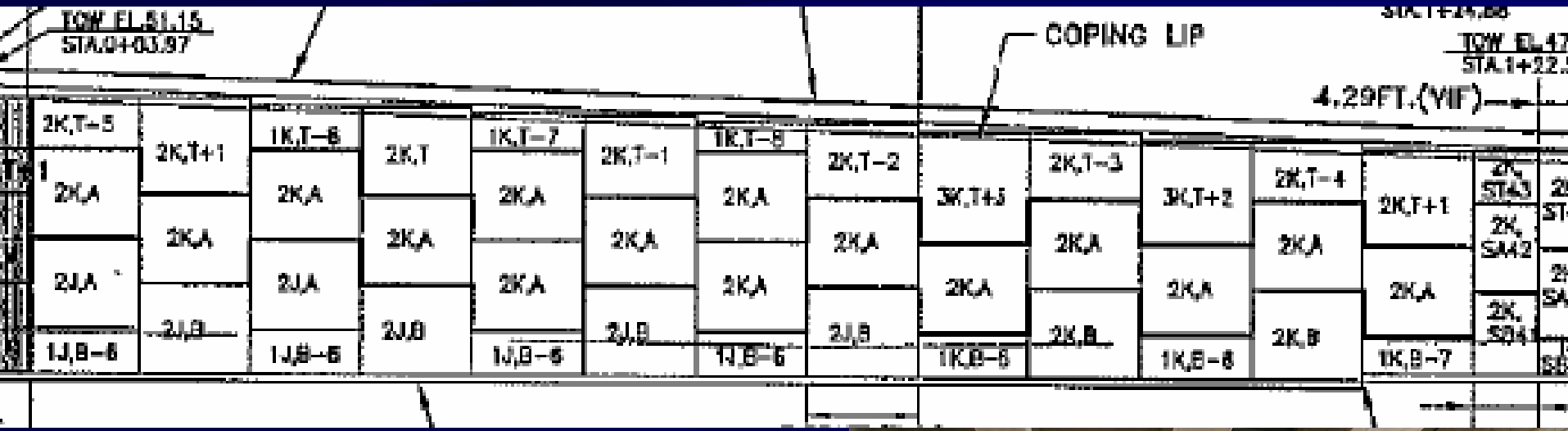
MSE Shop Drawings

- Design Calculations
- Panel Casting Drawings
- Erection Drawings

Shop Drawing Review

- May occur at District, Division, and/or Consultant.
- Submit shop drawings as early as possible to allow for reasonable review time.
- Both geometric and structural issues require review.
- Most errors/revisions involve coping, drainage, obstructions, and other appurtenances.

Wall 3A


TOW EL.81.15
STA.04+03.97
COPING LIP
4.29FT.(YIF)
2K,T-5
2K,T+1
1K,T-6
2K,T
1K,T-7
2K,T-1
1K,T-8
2K,T-2
3K,T+3
2K,T-3
3K,T+2
2K,T-4
2K,T+1
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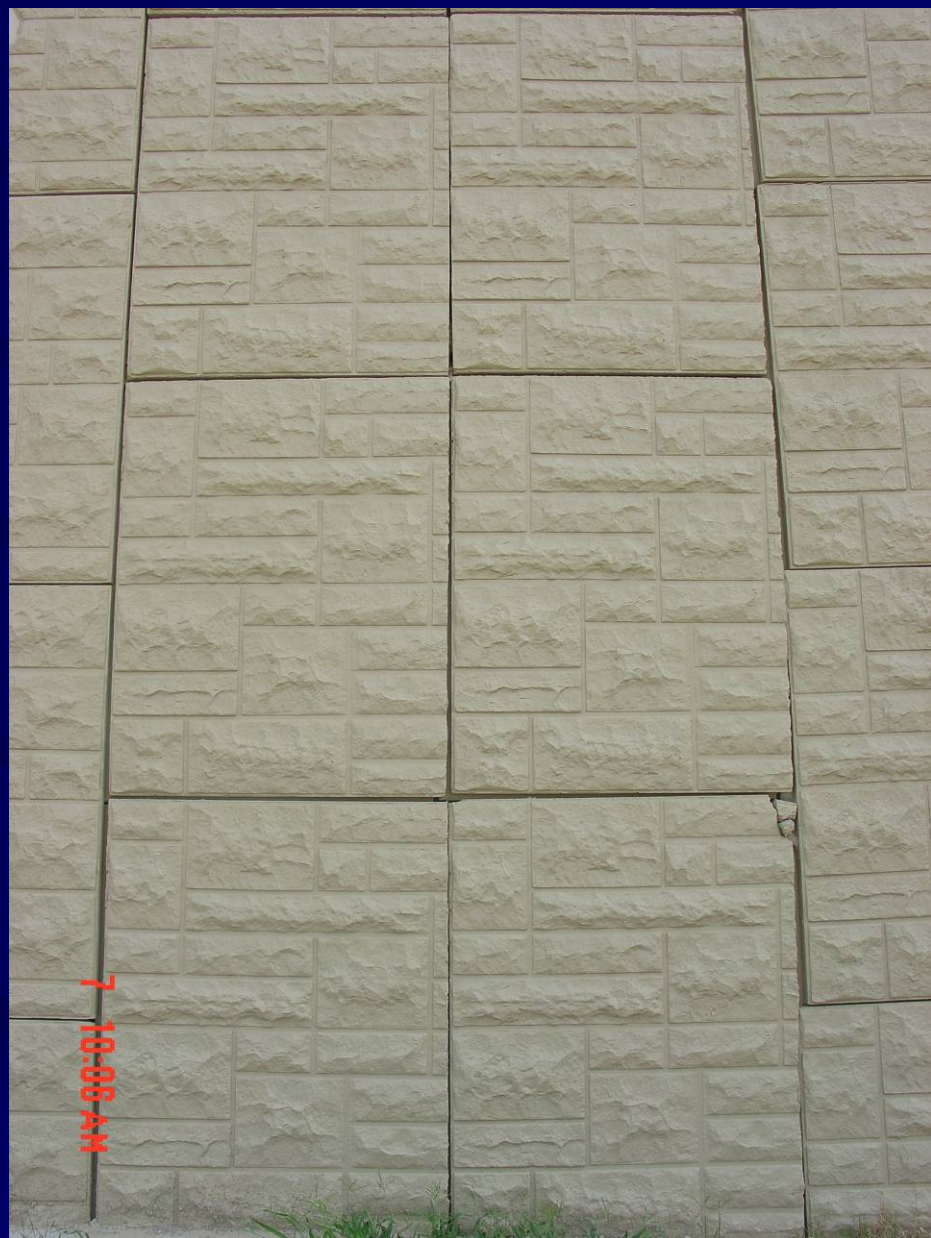
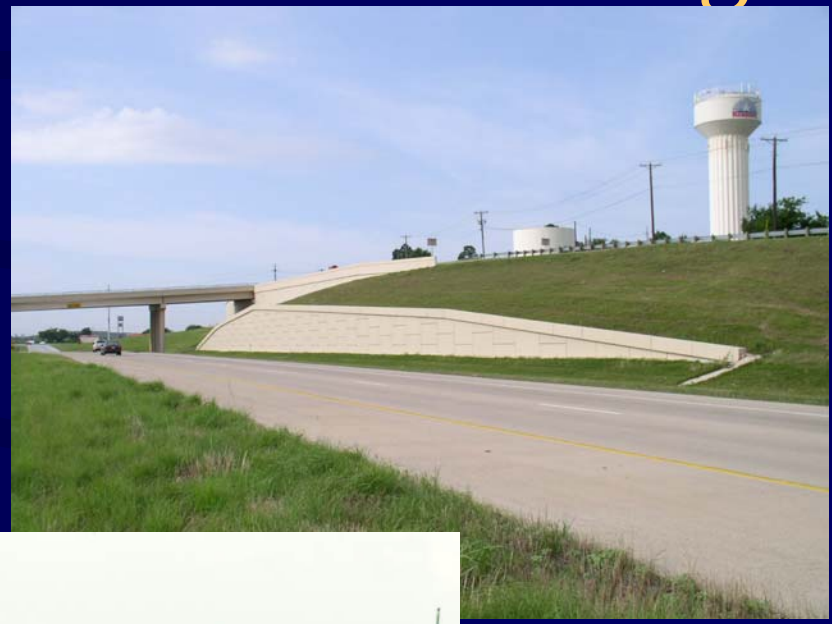
1K,B-7

MSE Shop Drawings



MSE Backfill Selection and Testing



Select Backfill - Testing

- Test select backfill prior to beginning of wall construction.
- Tests include gradation, pH, and resistivity.
  - Gradation controls strength, drainage, interaction with earth reinforcements.
  - pH and resistivity control corrosion and service life.
- 2004 Spec allows testing for soundness. Use if backfill appears made up of soft or shaley particles.

MSE Backfill Selection and Testing

			PROJECT TESTS		INDEPENDENT ASSURANCE TESTS		
MATERIAL OR PRODUCT	TEST FOR	TEST NUMBER	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	LOCATION OR TIME OF SAMPLING	FREQUENCY OF SAMPLING	REMARKS
EMBANKMENT (Retaining Wall Select Backfill)	In-Place Density (J)	Tex-115-E	As designated by the Engineer	One per backfill lift (K)			Tex-115E or other approved method.
	Gradation	Tex-110-E	At source, stockpile, or in place. (2)	Each 4,000 CY			(2)Engineer will select any one of these three locations or any combinations thereof with the provision that at least one of 10 samples will be taken in place.
	Resistivity (L)	Tex-129-E	At source, stockpile, or in place. (2)	Each 4,000 CY			
	pH	Tex-128-E	At source, stockpile, or in place. (2)	Each 4,000 CY			

(J) Place rock backfill or material that the engineer determines too coarse for density testing by the "ordinary compaction" method of Item 132, "Embankment."

(K) For walls greater than 500 lf in length, one test per lift per 500 lf.

(L) For material with resistivity between 1,500 and 3,000 ohm-cm, perform Test Method Tex-620J to determine chloride and sulphate content.

MSE Backfill
2004 Specifications

Type A, B, and D particles larger than 1/4 in. must be angular or crushed. Rounded rock or gravel is not allowed.

Table 2
Select Backfill Gradation Limits

Type	Sieve Size	Percent Retained
A	3 in.	0
	1/2 in.	50–100
	No. 4	See Note
	No. 40	85–100
B	3 in.	0
	No. 4	See Note
	No. 40	40–100
	No. 200	85–100
C	3 in.	0
	No. 4	See Note
	No. 200	70–100
D	3 in.	0
	3/8 in.	85–100

Note: Use No. 4 sieve for determination of rock backfill as described in Section 423.C, "Backfill."

When the backfill gradation results in 85% or more material retained on the No. 4 sieve, the backfill will be considered rock backfill. All Type D backfill is considered rock backfill.

Rock Backfill
Type A or D

Type B Backfill

Type ?????
Backfill

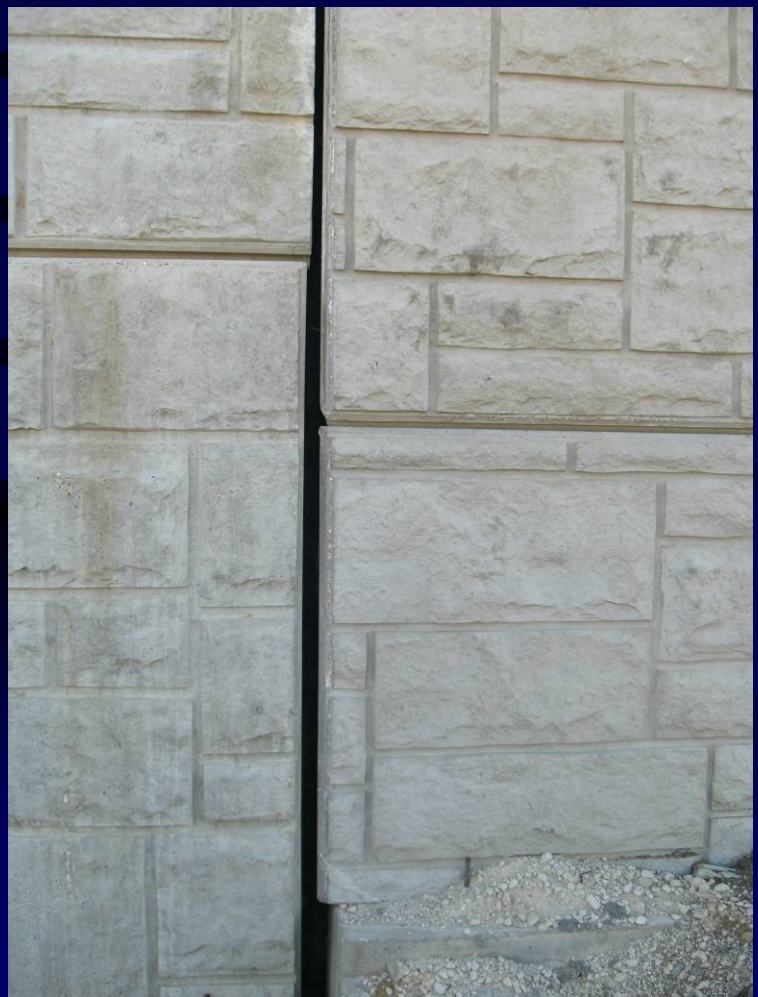
Type ?????
Backfill

Wall Construction Issues

- Panel Alignment (vertical and horizontal) and Panel Joint Spacing
- Hardware Damage
- Earth Reinforcement Installation
- Control of Water
- Special Connection Details

Wall Construction Issues

Panel Alignment (vertical and horizontal)



Wall Construction Issues

Panel Joint Spacing

RW(MSE) – Nominal Joint Opening between 3/8” and ¾”

Wall Construction Issues

Panel Joint Spacing

Wall Construction Issues

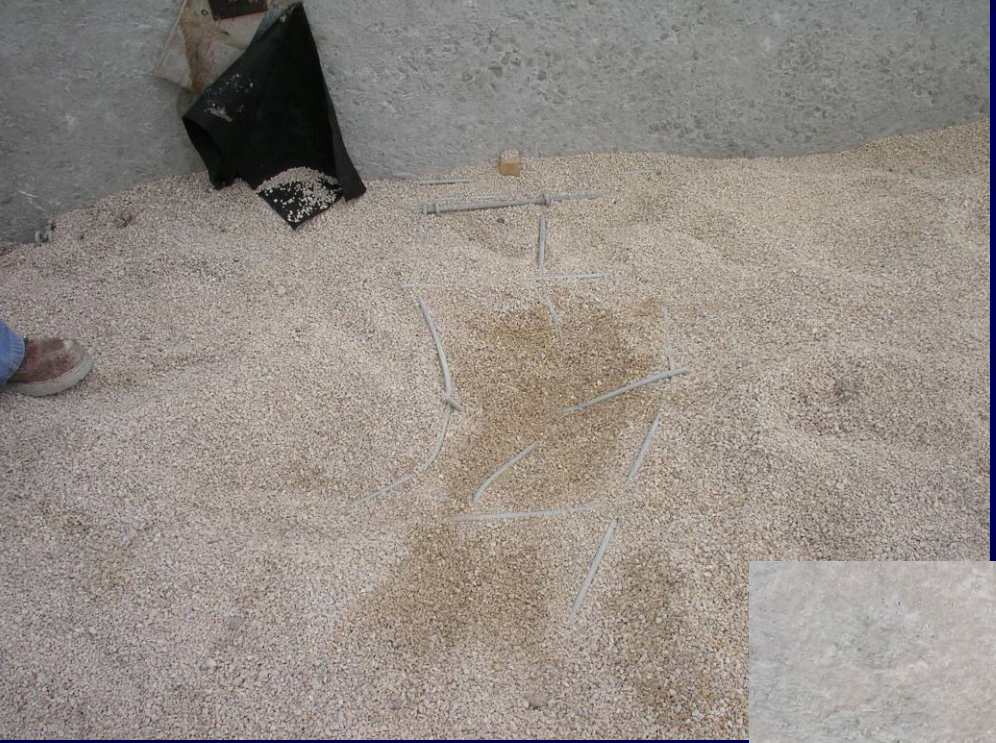
Hardware Damage

Wall Construction Issues

Hardware Damage

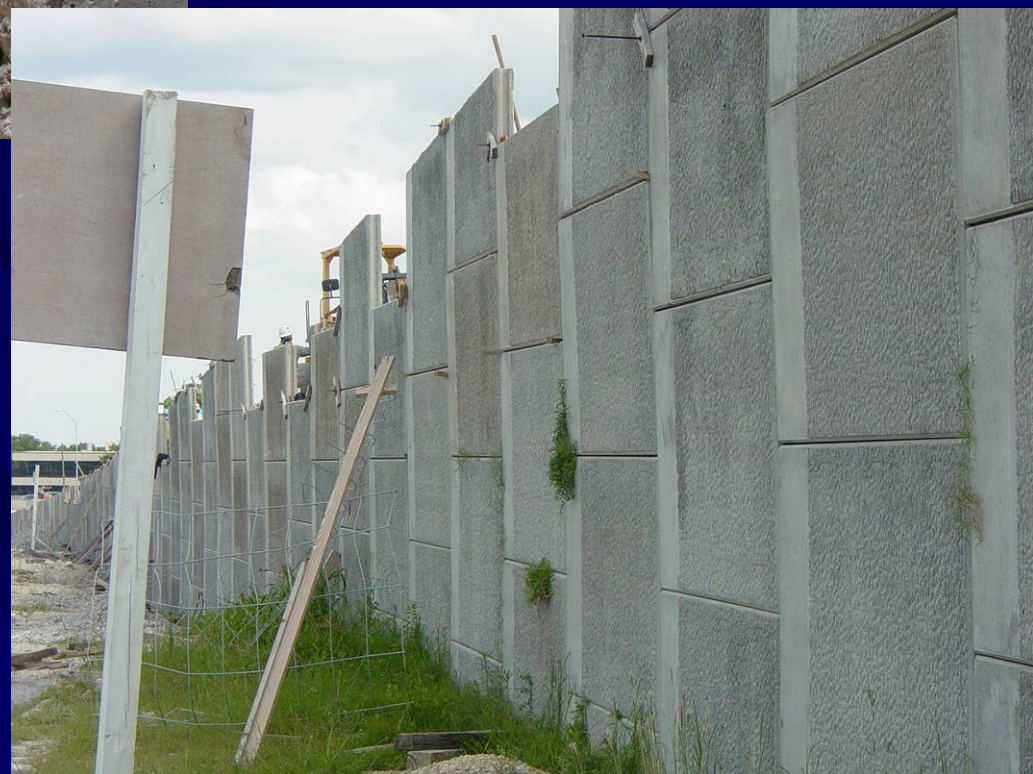
Wall Construction Issues

Earth Reinforcement Installation



Wall Construction Issues

Earth Reinforcement Installation

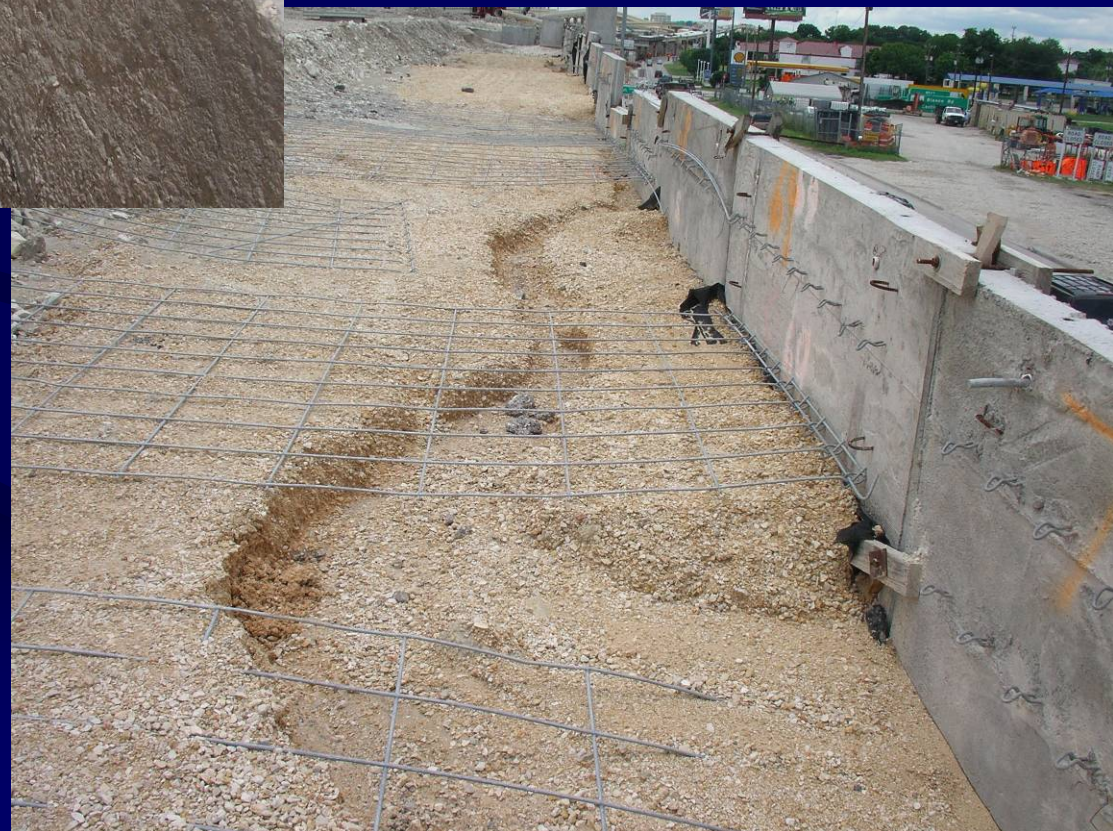


Wall Construction Issues

Control of Water

Wall Construction Issues

Control of Water



Wall Construction Issues

Control of Water

Wall Construction Issues

Control of Water

Wall Construction Issues

Control of Water

Wall Construction Issues

Special Design Considerations

2’ Clear

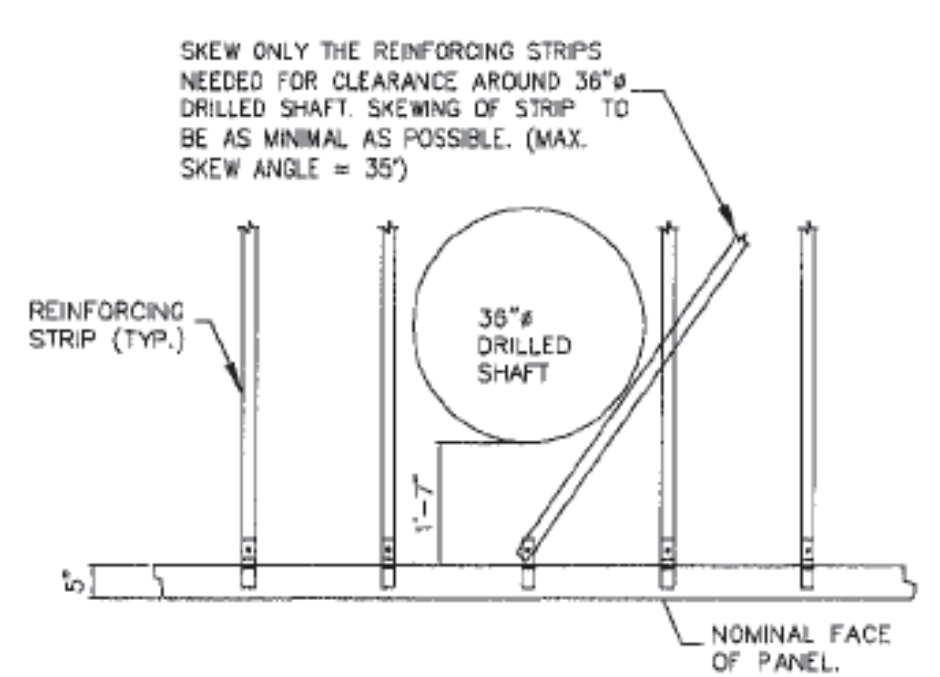
5’ desirable

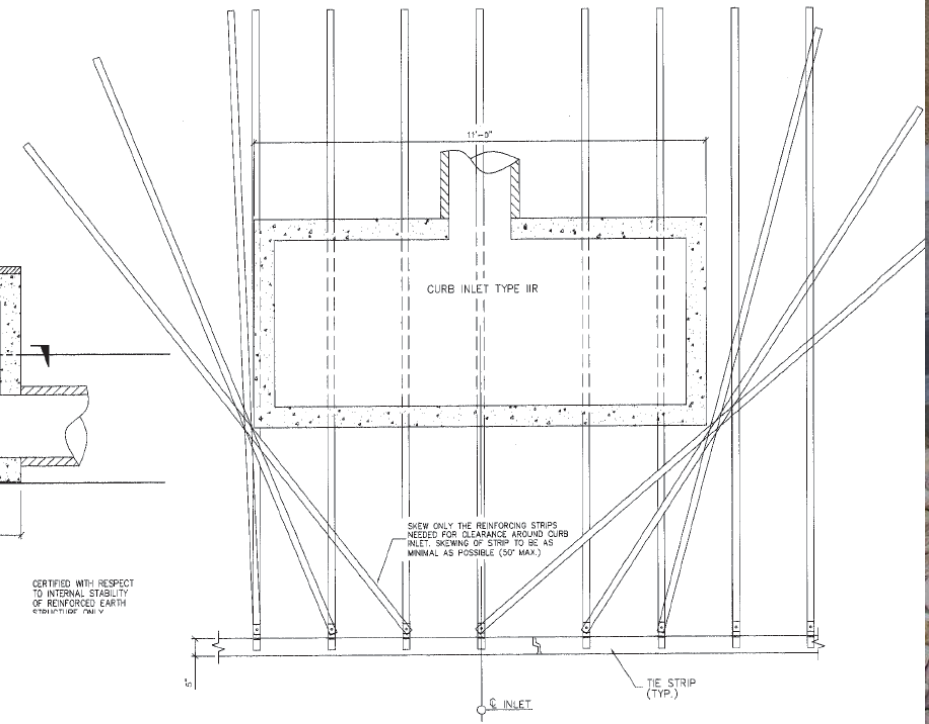
distance between back of panel and face of column

Wall Construction Issues

Special Design Considerations

Obstructions

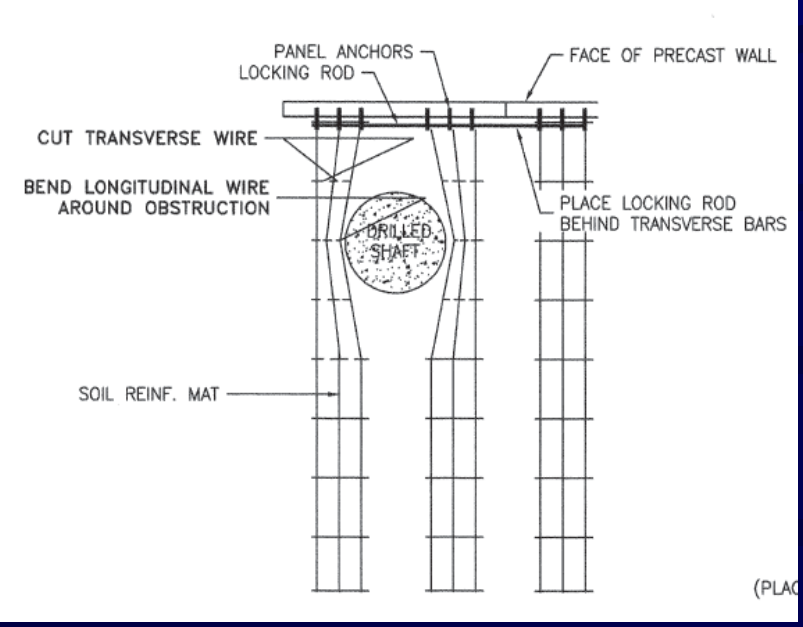


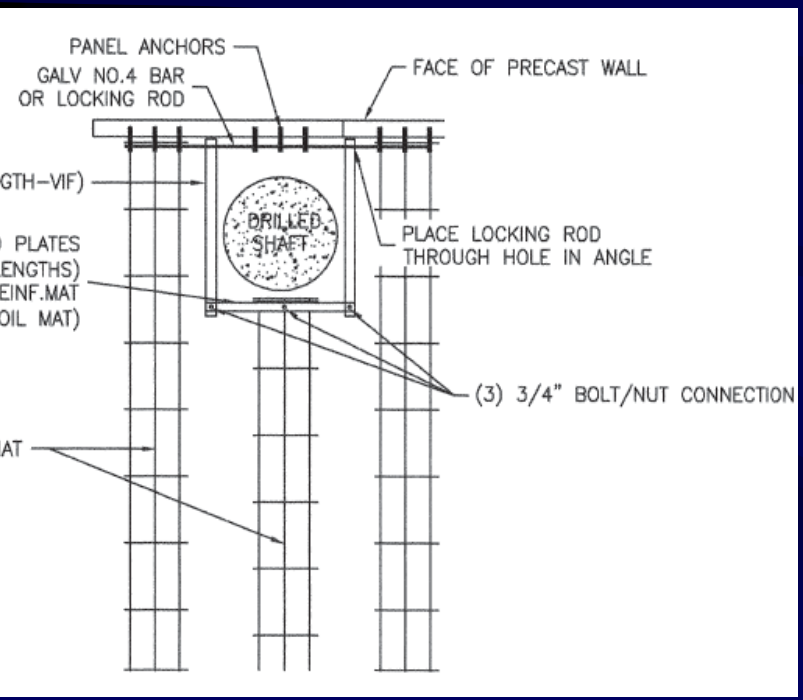


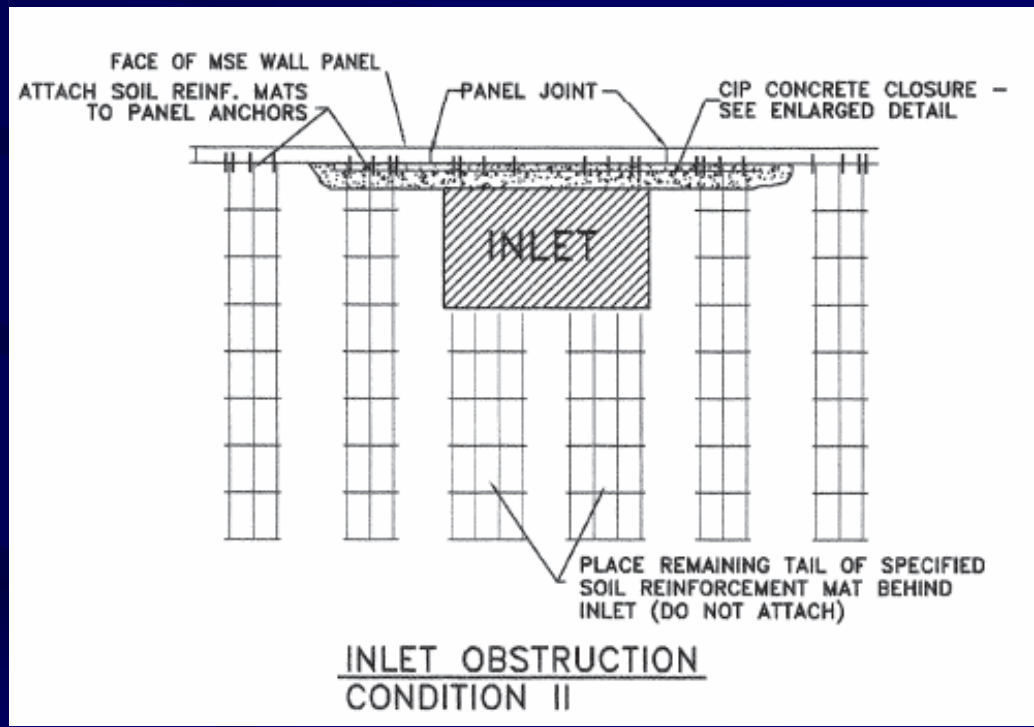
Wall Construction Issues

Special Design Considerations

Obstructions







OTHER CONSIDERATIONS
LOSS OF MSE BACKFILL

OTHER CONSIDERATIONS
LOSS OF MSE BACKFILL

OTHER CONSIDERATIONS

Corner Details

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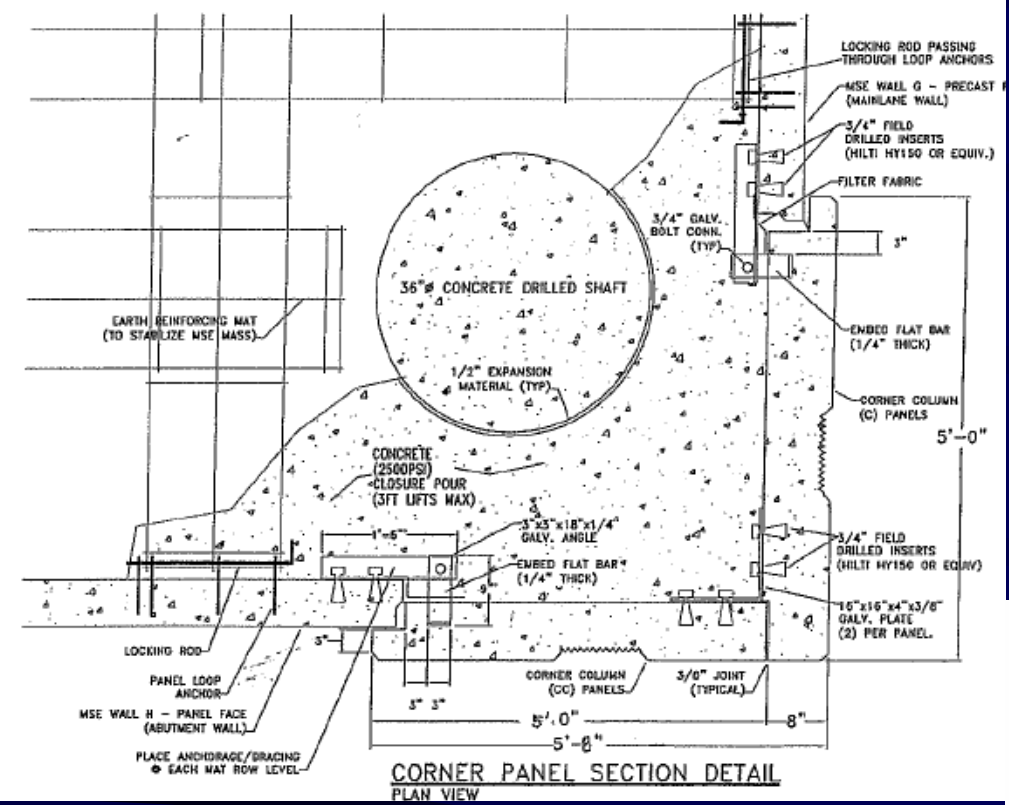
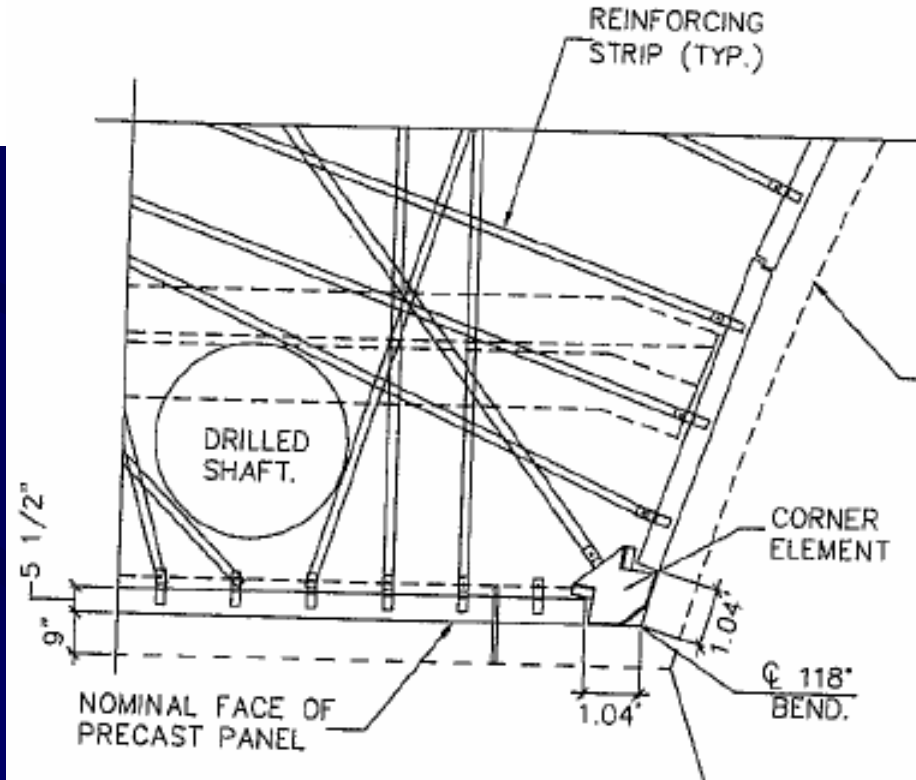




OTHER CONSIDERATIONS

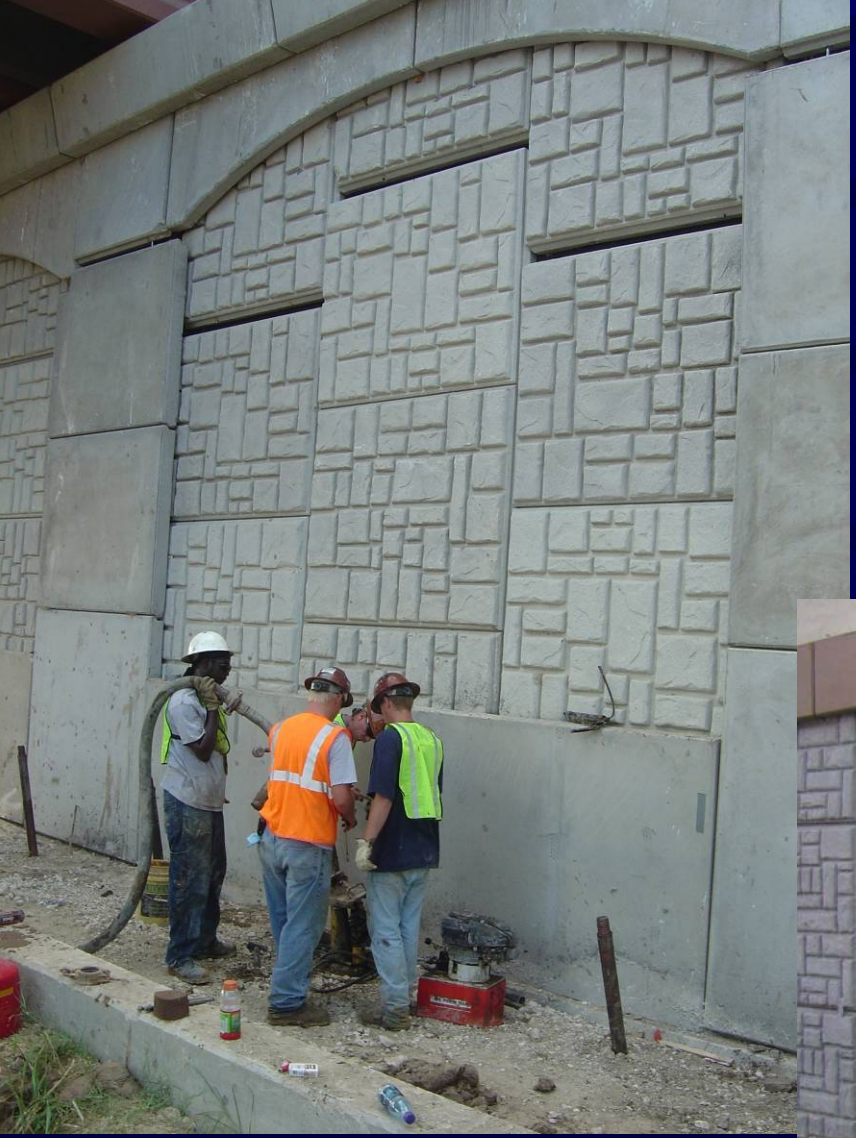
HARD POINT UNDER MSE RETAINING WALL LEVELING PAD

OTHER CONSIDERATIONS

POOR PREPARATION
OF RETAINING WALL
FOUNDATION SOILS

OTHER CONSIDERATIONS

POOR PREPARATION OF RETAINING WALL FOUNDATION SOILS



Questions?

Poorly Processed and Placed Embankment Material


9:19 AM