PROCEDURE FOR TAKING RANDOM SAMPLES OF BACKFILL MATERIAL FOR MECHANICALLY STABILIZED EARTH SYSTEMS

GEOTECHNICAL CONTROL PROCEDURE
GCP-20
Revision #1

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STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

GEOTECHNICAL ENGINEERING BUREAU

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PREFACE

The purpose of this manual is to provide New York State Department of Transportation Construction Inspectors with a uniform procedure for taking random samples of backfill material for mechanically stabilized earth systems. The procedure describes how to determine and randomly select sublots to eliminate bias.
TABLE OF CONTENTS

PREFACE ................................................................................................................................................. 2

TABLE OF CONTENTS ................................................................................................................................. 3

INTRODUCTION ............................................................................................................................................... 4

I. MECHANICALLY STABILIZED EARTH SYSTEM - GLOSSARY OF TERMS ................................. 5

II. QUALITY ASSURANCE - GENERAL ............................................................................................................. 7

III. FIELD SAMPLING ...................................................................................................................................... 8

A. Criteria ...................................................................................................................................................... 8
   1. Definitions ............................................................................................................................................ 8
   2. Minimum Requirements for Sampling Frequency ............................................................................... 9
   3. Additional Testing ................................................................................................................................. 9

B. Process ..................................................................................................................................................... 9

C. Sampling from the Grade .......................................................................................................................... 10
   1. Establish Top and Bottom Limits of Lots ......................................................................................... 10
   2. Determine the Sublot Sampling Elevation ....................................................................................... 11
   3. Determine the Sublot Width ............................................................................................................ 11
   4. Randomly Select a Sublot to Sample .............................................................................................. 11
   5. Randomly Select Four Locations within the Selected Sublot to Take Subsamples .................. 11
   6. Take Four Subsamples and Combine them into One Sample in a Gravel Bag ..................... 11

D. Sampling from a Dumped Truck Load ..................................................................................................... 12

E. Acceptance ............................................................................................................................................... 12
INTRODUCTION

Mechanically Stabilized Earth Systems (MSES) are internally stabilized fill structure comprised of an unreinforced concrete leveling pad, precast concrete face panel units and coping units, select granular backfill (reinforced backfill), subsurface drainage system, and reinforcing elements (high-strength, metallic or polymeric inclusions) to create a reinforced soil mass used to stabilize the backfill. Stability of these systems is achieved by the weight of the reinforced soil mass resisting the overturning and sliding forces generated by the lateral stresses from the retained soil behind the reinforced mass. MSES walls require a high quality backfill for durability, good drainage, constructability, and good soil reinforcement interaction which can be obtained from well graded, granular materials. The high quality backfill requirements provided in the MSES specification has established minimum or maximum electrochemical index properties to coincide with design procedures for the maximum corrosion rates associated with those properties. Backfills incorporated with buried steel elements of MSES walls which fall outside these ranges provide the potential for a reduced lifespan of the structure along with increased maintenance costs.

The intent of this manual is to provide a uniform and non-biased method by which the Department will select locations to take samples of backfill from behind a MSES structure during construction. This sampling is just one aspect of the overall QA process for MSES.
I. MECHANICALLY STABILIZED EARTH SYSTEM
GLOSSARY OF TERMS

1. **Fill Structure** – The fill type classification refers to the construction method used for the installation of the wall. Fill type retaining walls are retaining structures constructed from the base of the wall to the top (i.e. “bottom-up” construction).

2. **Internally Stabilized Fill Structure** – Internally stabilized fill structures are structures which rely on friction developed between closely-spaced reinforcing elements and the backfill to resist lateral soil pressure.

3. **Mechanically Stabilized Earth System (MSES)** – An MSES is an internally stabilized fill structure comprised of an unreinforced concrete leveling pad, precast concrete face panel units and coping units, select granular backfill (reinforced backfill), subsurface drainage system, and reinforcing elements used to stabilize the backfill.

4. **Backfill** – Any suitable material, meeting the requirements of §733-02 Mechanically Stabilized Earth System Backfill Material, which, when placed in conjunction with the reinforcing strips or mesh and the facing panels, comprise the reinforced volume.

5. **Connectors** – Galvanized metal tie strips or welded clevis loops cast into the back of a facing panel to which the reinforcing strips or mesh are attached.

6. **Coping** – Precast or cast-in-place concrete cap, which is placed on top of the MSES facing panels.

7. **Facing Panels** – Precast reinforced-concrete units which are part of the reinforced volume that forms the outside face of the MSES and are attached by means of the connectors to the reinforcing strips or mesh.

8. **Fasteners** – Bolts, washer, and nuts or connecting rods used to attach the reinforcing strips or mesh to the connectors.

9. **Joint Filler** – Material used to fill the vertical, angled and horizontal joints between the facing panels, consisting of either polyether foam or geotextile for all joints to prevent soil migration and resin-bonded corkboard or rubber bearing pads for the horizontal and angled joints for bearing.

10. **Leveling Pad** – A concrete pad or footing, usually unreinforced, which serves as a flat, level starting surface for placing the initial course of facing panels.
8. **Reinforced Volume** – A system of 1) facing panels, 2) reinforcing strips or mesh and 3) backfill, which, when constructed together according to specification, form one coherent mass.

9. **Reinforcing Elements** – An inclusion connected to the face panels and extending into the backfill for the purpose of backfill stabilization.
   
   **i. Inextensible Reinforcement.** A metal strip typically incorporating ribs on the top and bottom, or metal grids with design specific mesh openings.
   
   **ii. Extensible Reinforcement.** Geogrid or geotextile sheets typically made from high density polyethylene/ polypropylene geogrids or high tenacity polyester geogrids, or high strength geotextiles.
II. QUALITY ASSURANCE - GENERAL

The Department has established a Quality Assurance (QA) Program in accordance with 23 CFR 637 to assure the materials and workmanship incorporated into each Department project are in conformity with the approved plans and specifications. QA is outlined in 106-10 Quality Assurance.

Quality Assurance is defined as “all those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.” Quality Control is defined as “all Contractor/Vendor operational techniques and activities that are performed or conducted to fulfill contract requirements.” QA is an audit of the project deliverables quality and is an added phase in the process that not only ensures the Department that the specifications were met, but also supports the effectiveness of the QC program administered by the Contractors’ Supplier.

Mechanically Stabilized Earth System (MSES) walls require a high quality backfill for durability, constructability, satisfactory drainage and good soil reinforcement interaction which can be obtained from well graded, granular materials. The high quality backfill requirements provided in the MSES specification has established electrochemical index properties to coincide with design procedures for the maximum corrosion rates associated with those properties. Backfills incorporated with buried steel elements of MSES walls which fall outside these ranges provide the potential for a reduced lifespan of the structure along with increased maintenance costs.

The Department maintains a QA program instituted by the Geotechnical Engineering Bureau (GEB) for backfill material used in an MSES. QA for MSES backfill includes the following:

- Source evaluation
- Stockpile sampling and testing
- Sampling and testing material on the contract site. This may be from the grade or from behind a MSES Structure after placement by the Contractor or at any other location where the material is being stored or used.

The Department will sample and test backfill material obtained during the construction of the structure. Material determined not to meet the specification requirements will be rejected.
III. FIELD SAMPLING

The Department reserves the right to sample and test material on the contract site in order to be confident that the material placed in the work meets specification requirements.

As outlined in §105-05 Reasonable Close Conformity with Contract Documents, all materials furnished shall be in reasonable close conformity with the material requirements, including tolerances, shown in the contract documents. Contract specification values are to be considered as the target value to be strived for and complied with as the design value from which any deviations are allowed. It is the intent of the specifications that the materials and work quality shall be uniform in character and shall conform as nearly as realistically possible to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. Although maximum and minimum values are specified in the MSES backfill requirements, the production and processing of the material and the performance of the work shall be controlled so that material will not predominantly be of borderline quality or dimension.

It is the responsibility of the Contractor/Supplier to make sure that the methods used for delivering and handling the material does not result in a significant change in the material’s properties, such that the material goes “out of spec” due to segregation of particles.

A. CRITERIA

1. Definitions

The following definitions apply to the field sampling Quality Assurance (QA) program

i. **Lot:** A volume of MSES backfill that will be tested for QA. A lot size is designated by the Geotechnical Engineering Bureau (GEB) or by the Engineer. For typical MSES QA purposes, a lot is defined as approximately 1,000 yd$^3$ (800 m$^3$).

ii. **Level:** A level describes the horizontal extent of a sublot, with a thickness depicted by "T" (See Figures 1 and 2).

iii. **Sublot:** A volume from which four subsamples are taken and combined into one sample. For any given MSES structure, the number of sublots shall not be less than two.

   a. For samples taken from a dump truck, a sublot is one dump truck load, dumped into a pile.

   b. For samples taken on the grade, a sublot has the dimensions of L x W, where:

      \[
      \begin{align*}
      L & = \text{Reinforcement length} \\
      W & = \text{Width, or the distance of each sublot measured along the wall face.}
      \end{align*}
      \]

iv. **Subsample:** The amount of material taken from a hole dug in the grade. The size of a subsample is about one standard shovelful or approximately 11
Sample: A sample consists of four subsamples combined in a single granular material bag. The minimum size of a sample is 45 lbs (20 kg). There is no requirement for a maximum size, but a practical limit is 70 lbs (32 kg).

Note: For any MSES structure, the number of samples shall not be less than two.

2. Minimum Requirements For Sampling Frequency
The following are the guidelines for calculating the minimum QA field sampling and testing frequency per MSES structure.

i. Determine the level thickness "T" by dividing the maximum height of the MSES structure by the number of samples required by the General Soils Laboratory of the Geotechnical Engineering Bureau.

ii. Establish the number of samples and their locations (plan and elevation) as described in III.C. Sampling from the Grade.

3. Additional Testing
The Department may elect to take additional field samples, supplementing the minimum required field samples, at any time as part of the overall QA process.

i. The number of these additional field samples will be determined based on a history of the source, the quantity of material being placed, and scheduling agreements.

ii. The locations of these additional field samples will be established at the time of arrival.
   a. From the grade: described in III.C. Sampling from the Grade. Use steps 3 thru 6 to sample the material. The elevation of the sampling will be from the top of the backfill position at the time of arrival.
   b. Dump truck: described in III.D. Sampling from a Dumped Truck Load.

B. PROCESS

Quality Assurance samples taken in the field can be obtained two ways; sampling from the grade, or sampling from a dumped load. A sample should be taken representing each lot.
C. SAMPLING FROM THE GRADE

Sampling from the grade means taking samples of backfill material that has been placed and graded behind the wall. The material may be loose or compacted. General steps for sampling from the grade are as follows:

1. **Establish the Top and Bottom Limits of the Sublots.** Determine the top and bottom limits of each subplot. Designate each level with a letter, starting with "A" and proceeding sequentially (See Figure 1).

2. **Determine the Sublot Sampling Elevation.** Using the principles described in ASTM D3665 or an equivalent method of generating a random number (document on the DWR in SiteManager the method utilized for generating the random number), randomly determine the vertical distance "Z", measured from the bottom of the level, which establishes the elevation to take samples. The distance "Z" shall be equal to or greater than 225 mm (9 inches), but shall not be greater than T (See Figure 2). Recalculate Z for each level.

Ex: **Given:**
Total backfill volume = 3500 yd$^3$

T$_T$ Wall height = 20 ft.
Number of samples required = 1 per 1000 yd$^3$

Find T: $= (1/1000)*(3500)$
$= 3.5$ samples (Round to 4)
Sublot Thickness “T” = Total wall height / number of samples
$= 20$ ft. / 4
T: $= 5$ ft.

Figure 1: Sample Elevation View of MSES Wall Face – Not To Scale
3. **Determine the Sublot Width.** The sublot width shall be approximately 15 ft. (4 m). Adjust the width from the default value of 15 ft. (4 m) so that there is a whole number of sublots for the entire level. Each sublot per level shall be equal in width. Assign a sequential number to each sublot for each level. (See Figure 3).

4. **Randomly Select a Sublot to Sample.** Using the principles described in ASTM D 3665 or an equivalent method of generating a random number, randomly select a sublot to test. Repeat for each level.

5. **Randomly Select Four Locations within the Selected Sublot to Take Subsamples.** Using ASTM D 3665 or an equivalent method for generating a random number, generate a random number, multiple it by the sublot width to get the "x" coordinate of the subsample location. Then generate another random number and multiply it by the length L to get the "y" coordinate of the subsample. Repeat this procedure to obtain the locations of a total of four subsamples.

6. **Take Four Subsamples and Combine them into One Sample in a Gravel Bag.** Using a hand shovel, dig a hole and remove a sample of backfill material, and place it in a sample bag* (supplied by the GEB). The depth of the hole should be approximately 3/4 of the lift thickness. The hole should be approximately conical in shape. Remove all loose material from the hole and include it with the sample(s).

   *Note: When collecting two sets of samples (one for project-level gradation testing, and one to be sent to the GEB General Soils Laboratory), take two shovels full at each subsample location. Place one in the sample bag to be tested by the project, and one in a separate bag to be sent to the General Soils Laboratory (GSL).

Perform this procedure for all four subsampling locations for each sublot.

Follow Geotechnical Control Procedure (GCP-17) *Procedure for the Control and Quality Assurance of Granular Materials*, Section 2.4 D-3d for sample documentation and sealing instructions.
Upon completion of the sampling, backfill the holes with material from the same stockpile from which the sampled material originated, and compact all material placed in accordance with the specification for MSES.

**D. SAMPLING FROM A DUMPED TRUCK LOAD**

Use the same approach as is currently described in Geotechnical Control Procedure (GCP-17) *Procedure for the Control and Quality Assurance of Granular Materials*, Section 2.4.2 D-3.

**E. ACCEPTANCE**

For this project, acceptance will be based on the evaluation of the QA sample assessed under the following tests:

1. Gradation testing performed by NYSDOT project staff or others.
2. Corrosion Potential, Durability and Plasticity testing performed by the General Soils Laboratory (GSL) of the GEB.
3. Chemical testing performed by the Materials Engineering Bureau (when applicable).

The GSL may perform gradation testing for monitoring purposes.

![Figure 3: Oblique View of a Lot with Sublots, At Level A - Not To Scale](image-url)