METHODS OF SAMPLING AND TESTING
MT 207-21
BULK SAMPLING OF SUBSURFACE INVESTIGATIONS

1 Introduction

1.1 Subsurface investigations are an essential part of preliminary highway engineering. Information on the engineering properties and distribution of soils, rock and groundwater must be obtained before a reasonable and economic highway design can be developed.

1.2 Subsurface investigation work depends on many factors which include scope of the proposed project, types and variability of materials found on the project, groundwater conditions, adverse geologic features, etc. Often field conditions found during the investigation will increase or decrease the amount of work needed to supply the necessary information for design. Borings conducted by multiple work units must be coordinated to preclude duplication of effort.

2 Referenced Documents

2.1 ***AASHTO***

M 145 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
T 84 Specific Gravity and Absorption of Fine Aggregate
T 85 Specific Gravity and Absorption of Coarse Aggregate
T 190 Resistance R-Value and Expansion Pressure of Compacted Soils
T 255 Total Evaporable Moisture Content of Aggregate by Drying

MT Materials Manual

MT 202 Sieve Analysis for Fine and Coarse Aggregate
MT 210 Moisture-Density Relations of Soils Using a 5.5 lb. Rammer
MT 230 Moisture-Density Relations of Soils Using a 10 lb. Rammer
MT 232 Soil Corrosion Test

3 Apparatus

3.1 *Sampling tools*

Hand shovels, picks, etc.
Hand augers, post hole diggers
Power augers and drills, etc.
Backhoes

3.2 *Instruments (optional)*

Survey equipment
Digital camera
GPS

3.3 *Miscellaneous*

Stakes and lath
Sample bags (17”X 28” canvas, 75 lb. capacity)
Sealed containers (jars or plastic bags)
Field notebooks and forms

4 Procedure A – Field Investigation Unit (FIU) Geotechnical Boring

4.1 General Procedure

Follow the general procedure outlined below when conducting geotechnical borings with the FIU. The complexity of the subsurface investigation will depend upon many factors as discussed in Section 1.2 above.

Note 1 – Geotechnical personnel will submit utility locate requests prior to boring operations.

4.2 Geotechnical and Pavement Bureau or District Materials staff may perform reconnaissance. Coordinate information gathering during the boring planning meeting associated with EPS Activity 455.

4.3 Preliminary investigation Plan

4.3.1 Develop a preliminary plan prior to field work during the EPS Activity 455 coordination meeting. Base the preliminary plan on available information and intended scope. Determine sample site locations to enable proper soil profile determination and adequate sampling. This plan will likely change as information is gained during the subsurface investigation process.

4.3.2 Geotechnical personnel will keep the boring records.

Geotechnical Bureau personnel will log each test hole, boring, test pit, or cut-surface exposure with the field description and location of each material encountered in accordance with the MDT Geotechnical Manual.

Note 2 – Color photographs of samples and exposed strata should be obtained and are of considerable value to the Department. Each photograph should include a date and an identifying number or symbol.

4.4 Bulk Sampling

Collect bulk samples for laboratory analysis from areas that may supply appreciable quantities of earthwork and known borrow areas. Geotechnical personnel will collect the appropriate bulk samples of disturbed material and District personnel may assist with this effort if they are available and onsite. The spacing of these investigations and sample collection intervals will depend upon the geologic complexity of the project area and upon the importance of soil and rock parameters to the project design. The required depth and sample collection should be in accordance with guidelines provided in the MDT Geotechnical Manual.

4.4.1 Clear the sample area of any surface debris (twigs, rocks, etc.). When possible, clear an appropriate area around the hole to prevent near-surface soil particles from falling down the hole and contaminating the sample.

When drilling with augers, samples may be collected from cuttings as they accumulate around the hole, taking care to clear unnecessary material as it accumulates and as layers change. Due to safety concerns, samples should only be obtained when augers have been stopped and are not turning.

4.4.2 Collect bulk samples representative of the strata encountered. Minimum sample sizes are described in MT 202. If a given soil layer is relatively thin, collecting a sample of adequate size may not be possible. Collect as much material as practicable.

Collect moisture samples and place them in sealed containers. The sample size is in accordance with AASHTO T 255. Keep samples for natural moisture determination in sealed containers to prevent moisture loss. When drying of samples may affect classification or engineering properties, protect them to minimize moisture loss.

Collect samples, not less than 5 lbs., for corrosive testing in accordance with MT 232 and place them in sealed containers.

4.4.3 Accurately identify each sample with the project identification, location, date, test site number and depth below reference ground surface where it was collected. Place identification inside the container, securely close the container, protect it to withstand rough handling, and mark it with proper identification on the outside of the container.

5 Procedure B – District Laboratory Boring

5.1 Rehabilitation Projects and Miscellaneous District Requests

5.1.1 Develop a preliminary plan prior to field work based upon district reconnaissance, available information, and intended scope. Determine approximate sample site locations to enable proper soil profile determination and adequate sampling. This plan will likely change as information is gained during the actual construction of the test sites.

Note 3 – District Materials Lab staff will contact 811 and confirm utility locations prior to boring operations.

Resources used to develop a preliminary plan may include, but is not limited to, the following items.

- Geotechnical and Pavement Bureau records
- Maintenance records
- Construction records
- Topographic and geologic maps
- Historic use information for the area
- USDA Soil Conservation Service
- County soil survey reports
- Utility company maps and locations
- City and county plat maps
- Information from landowners and businesses
- Aerial photography

5.1.2 Required survey data for all projects

The PTW should be drilled at least 5 feet into the subgrade and sampled in the driving lanes (not the shoulder) as frequently as necessary.

5.13 Standard sampling frequency is typically one per ½ mile, or as conditions dictate.

Log each test hole, boring, test pit, or cut-surface exposure with the field description and location of each material encountered, in accordance with the MDT Geotechnical Manual. Record coordinates with survey equipment or GPS, if requested. Log the depth of each strata. Note and log the mat thickness. Note and log base thickness and subgrade. Indicate reason for termination of the boring hole (groundwater, refusal, bit length, stopped in same material, etc.).

5.2 Bulk Sampling

Collect bulk samples for laboratory analysis from all areas that may supply appreciable quantities of earthwork and known borrow areas. District staff will collect the bulk samples of disturbed material. Geotechnical staff will collect undisturbed samples of the same material. The spacing of these investigations will depend upon the geologic complexity of the project area and upon the importance of soil and rock parameters to the project design. The depth should be a minimum of five feet below the proposed top of subgrade elevation or to borrow area depth.

5.2.1 Clear the sample area of any surface debris (twigs, rocks, etc.). When possible, clear an approximately 6-inch radius around the hole to prevent near-surface soil particles from falling down the hole and contaminating the sample. Samples should be collected from tailings piles as they accumulate around the hole, taking care to clear unnecessary material as it accumulates and as layers change.

5.2.2 Collect bulk samples representative of the strata encountered. Minimum sample sizes are described in MT 202. If a given soil layer is relatively thin, collecting a sample of adequate size may not be possible. Collect as much material as practicable.

Collect moisture samples and place them in sealed containers. The sample size is in accordance with AASHTO T 255. Keep samples for natural moisture determination in sealed containers to prevent moisture loss. When drying of samples may affect classification or engineering properties, protect them to minimize moisture loss.

Collect samples, not less than 5 lbs., for corrosive testing in accordance with MT 232 and place them in sealed containers.

5.2.3 Accurately identify each sample with the project identification, location, date, test site number and depth below reference ground surface from which it was taken. Place identification inside the container, securely close the container, protect it to withstand rough handling, and mark it with proper identification on the outside of the container.

Provide a narrative summary with the investigation describing the bore hole and material characteristics.

5.3 New and Reconstruction Projects Only

5.3.1 Additional survey data for new and reconstruction projects only are as follows.

Review planning reports and anticipate alignment and grades.

Locate test holes in the field to provide engineering soil properties where appreciable quantities of excavation will occur. Depth will be determined by the new grade line with holes extending about five feet below the proposed subgrade line. Typical sampling frequency is one per 1/2 mile, as conditions dictate and as indicated by field review.

Keep a log of the test holes and plot the test holes on a profile sheet.

Review data collected to determine if additional test sites (i.e., areas of refusal, inadequate depth, or questionable frequencies) are required.

Note topsoil depth and availability.

6 Testing (Procedures A and B)

6.1 Discuss appropriate testing for the project scope of work with the Geotechnical and Pavement Bureau personnel before any testing is performed. As applicable and based on the discussion, testing analysis should be performed on requested samples for the following items and recorded on the appropriate worksheets.

6.1.1 For **Procedure A**, provide test results to the Geotechnical Bureau for inclusion in the EPS Activity 460 report.

6.1.2 For **Procedure B**, record test results in the District Subsurface Investigation Report, as described in Section 8.

6.2 Bulk Samples

Perform a sieve analysis of fine and coarse materials in accordance with MT 202. Classify the soils in accordance with AASHTO M 145. Perform moisture-density relation analysis in accordance with MT 210 and MT 230.

Send applicable materials of greater quality than A-6 classification to the Materials Bureau for potential R-value testing in accordance with AASHTO T 190. R-value testing needs will be determined as discussed in section 6.1

If the District Lab chooses, specific gravity testing on fine and coarse materials may be performed in accordance with AASHTO T 84 and T 85, respectively.

6.3 Moisture Samples

Determine the total evaporable moisture content of the material in accordance with AASHTO T 255. Record this information in the Construction Report (see Section 8) and note if the moisture content at the time of sampling exceeds the optimum moisture content, as determined by MT 210 or MT 230.

7 Interpretation of Results

7.1 Interpret the results of the investigation only in terms of actual findings and make every effort to collect and include all field and laboratory data from previous investigations in the same areas. Extrapolation of data into local areas not surveyed and tested can be done only where geologically uniform subsurface conditions of soil and rock are known to exist. Engineering properties of the soils and rocks encountered on important projects should not be predicted wholly on field identifications or classification but should be checked by laboratory and field tests made on samples collected.

8 District Subsurface Investigation Report

8.1 Include the following in a Subsurface Investigation Report

8.1.1 Locate the area investigated in terms pertinent to the project. This may include sketch maps or aerial photos identifying the location of the test holes, pits, and sample areas, as well as topographic items relevant to the determination of the various soil and rock types, such as contours, streambeds, sink holes, cliffs, etc. Where feasible, include a geologic map of the area investigated in the report.

8.1.2 Coordinate reporting of field data with Geotech Bureau to complete Bore logs.

8.1.3 Upload copies of all borings, test-hole logs and laboratory test results to MDT's Document Management System (DMS). A DMS Help Guide for District Materials is available online. Notify the Geotechnical and Pavement Bureau and the District Preconstruction and Construction personnel that the information is available for viewing on DMS.