

GEOTECHNICAL LABORATORY

NOTES ON REPORT WRITING

Experience has demonstrated that the ability to express oneself effectively, both orally and in writing, is one of the most valuable assets of the professional engineer. Among the opportunities for acquiring this skill while attending the University are the reports of the various kinds that students are called upon to submit in a number of technical courses. In soil mechanics, reports of laboratory experiments are required. This requirement is set forth with the following objectives:

1. To acquaint the student with some of the important laboratory tests for measuring the engineering properties of soils.
2. To encourage the student to study the literature to obtain information pertinent to the problem at hand.
3. To develop the student's ability to analyze and interpret data, to reason logically, and to arrive at correct conclusions.
4. To afford the student and opportunity for further formal practice in report writing.

The following notes have been prepared to assist in the achievement of these objectives.

FORMAT

The arrangement of subject matter depends upon the character of the report. For example, the report of an engineering consultant would most likely include such topics as authorization, information made available and test performed, submission of data, analysis and interpretation of data, results and discussion of results, conclusions and recommendations. If the report is lengthy, a synopsis emphasizing the salient features is frequently included near the outset. For reports of this nature, a standardized format is neither necessary nor desirable. On the other hand, for reports that are repetitive in nature (among which those recording laboratory experiments may be included), adherence to a specific arrangement of material is usually desirable. The following form is required for the laboratory reports in soil mechanics.

Title Page
Table of Contents
Purpose
Conclusions
Theory
Apparatus
Procedure
Data and Sample Calculations
Results
Discussion of Results
Appendices
Bibliography
Participation

GENERAL REQUIREMENTS

The technical report must be complete and accurate. Embodied in these requirements is the essence of engineering training, since they cannot be fulfilled unless the reporter can think logically and accurately. Accordingly, the most important requirement of an engineering report is accuracy and this feature will be accorded the most serious consideration in judging its value.

On the other hand, the report is prepared not merely to document the engineer's work. It is intended to convey to others (engineer's executives, politicians, and the general public) the judgment of the engineer, including the facts and the reasoning on which this judgment is based. For these reasons, the engineer should develop the ability to write clearly and concisely and to keep his discussion on a level commensurate with the background and training of the individuals for whom the report is intended. In this connection, the function of grammar is akin to that of a code of engineering practice, each seeking to describe and classify – in their respective fields – current concepts of good practice. It would seem logical, therefore, that if a familiarity with the regulations of a building code are prerequisites to safe, economical building design, that the same attention to the rules of grammar is essential to good writing. Grammatical errors and misspellings often lead to serious misinterpretations, and they reflect the basis of which the report as a whole may be judged. A carelessly written report invites suspicion regarding its technical validity.

SPECIFIC REQUIREMENTS

These requirements are outlined under the topics listed in the format and in the order in which they appear therein.

Title Page: The title page should include the title of the experiment, the name of the experimenter, and whom and for whom the report is being prepared, and the appropriate standard or specification number of the test, and where and when the experiment and the report were executed.

The lead pages should be headed by a brief title.

Table of Contents: This is a list of the major topics and subheadings and the corresponding page numbers.

Purpose: In many engineering reports the purpose is usually stated in general terms under the heading "Preface" or "Introduction". The objectives may then be specifically outlined under the heading "Scope". For the laboratory reports in soil mechanics, it will be sufficient for the purpose to be phrased in concise statements of its objectives. Attention is directed to the importance of starting carefully the objectives of the experiment. The purpose as stated in the laboratory manual should not be copied. The conclusions to be drawn (in fact, whether there are any conclusions or only results) depend upon how the objectives of the report are phrased. For example, the "purpose" of the specific gravity test may be as follows.

1. To determine the relationship between temperature and the weight of a 500mL volumetric flask filled to the calibration mark with distilled water.
2. To determine the specific gravity of a medium-fine beach sand.

In this instance, the results of the experiment should contain a calibration curve of the flask and a statement regarding the numerical value of the specific gravity of the sand. According to the phrasing of the objectives to the report, no conclusions are warranted, since no statement has been made regarding the purpose for which the specific gravity of the soil is to be used. These concepts will be enlarged upon when the topics entitled "Conclusions" and "Results" are discussed.

Conclusions: A conclusion is a reasoned judgment based on facts aimed in the purpose of the study. The conclusion should relate the purpose of the experiment to the results attained.

Theory: In laboratory reports prepared for industrial organizations, this topic would usually be omitted. However, since the reports in soil mechanics are for instructional purposes, the inclusion of pertinent theory is required. The theory should include the requisite material for an understanding of the purpose of the tests, or procedures used, of the test results. It is suggested

that the theory be made as complete as possible, consistent with the individual's interest in the subject. The minimum requirements are as follows:

1. Definitions of all the special terms pertinent to the experiment.
2. A statement of all formulas used with definitions of all symbols and their corresponding units, as well as a brief discussion regarding the range of their validity.
3. A summary of the engineering applications of the results of the experiment, including any interpretations that are necessary to achieve this purpose.
4. A short discussion of the theory and how it pertains to the pertinent experiment.

Apparatus: In a laboratory report, the apparatus used to perform the experiment should be adequately described and the materials tested or the specimens used identified accurately. In some instances a word definition alone will suffice, but to be useful, it must be complete and specific. For example, one method of determining the grain-size distribution of a fine-grained soil requires the use of a specific gravity hydrometer, the proper listing of which would be:

Streamlined bulb, specific gravity hydrometer, range 0.995 to 1.010, sensitivity 0.001, calibration 20°C/20°C (i.e. it is calibrated to read the specific gravity of a fluid at 20°C, with reference to distilled water at 20°C).

A description of a balance should state its type, capacity and sensitivity. Similar information can be given for other pieces of apparatus.

When special types of apparatus are used (that is, those that are not readily available in the equipment catalogs), or when a number of different units are connected together to form a "set-up", it is desirable to supplement the word description by a visual aid – photographs, drawings and sketches being used most frequently by engineers. In general, photographs are used to show what the apparatus or specimen looks like (particularly if there is considerable detail). Drawings are prepared if it is desired to give information suitable for constructing the apparatus. Engineering sketches can be used for both of the purposes stated above (though usually with less effectiveness) but are superior to other visual aids if the reported is seeking to describe how an apparatus works.

A good sketch enhances the value of a report, but extremely elaborate sketches are unwarranted and are a waste of time. In some instances, a neat line diagram is all that is necessary.

It should be recognized that the words complete, adequate, and the like, as applied to writing descriptions of apparatus, procedures, etc. are only relative. The reporter must learn to discriminate between what is and what is not essential. Opinions on this matter differ, even among experienced and accomplished writers. The beginner is advised to err on the side of completeness rather than incur the risk of omitting essential facts.

Procedure: The procedure should describe how the experiment was (or is to be) carried out. In describing a test that has already been performed, always use the past tense.

Many procedures for laboratory tests have been standardized. In these instances, a direct reference to the literature indicating the procedure followed will suffice. In other cases a general summary of the test procedure will serve the purpose. In case of special procedures a detailed test procedure should be included. In some instances it may be desirable to list a step-by-step account of each task performed in the order of its performance in the actual experiment. The required precision of all measurements should be noted.

A detailed procedure is required in reports for CE 343.

Data and Sample Calculations: Prepared forms are invariably used on which a running log of the measurements made and the readings taken are recorded. Occasionally these forms are

provided with additional columns in which the answers to various steps in the computation of the results are placed. Since it is often desirable to include the original data in the formal report, they should be complete and nearly kept. An original observation should never be erased even if it is discovered to be incorrect. If another reading or measurement is made to correct a mistake, the faulty observation should be crossed out with a single line and the corrected value inserted immediately adjacent to it.

Sample computations are included for the purpose of showing the reader how the results were calculated. They should be sufficiently complete to permit easy checking by someone who may not be thoroughly familiar with the nature of the experiment. To the reported (who has just completed the computations) a brief sample may seem adequate, but to the reader it may be entirely incomprehensible.

Results: A result is an answer or a fact obtained, achieved, or brought about by measurement, calculation, investigation, or the like. Often, it is difficult to distinguish between a result and a conclusion. As a guide, the following question may be raised: Is it a reasoned judgment or is it a fact obtained by measurement or calculation? In borderline cases, it might be advisable to include the statement under both headings.

Some writers do not make a distinction between data or supplementary values that are steps toward obtaining results and the results themselves. There are circumstances in which such a distinction destroys continuity and, therefore, may be objectionable. However, it will usually be desirable to list the results under a separate heading.

It is sometimes just as difficult to distinguish between raw data and results as it is to separate results from conclusions. If the values measured or computed are (either wholly or in part) answers to the objectives of the experiment or if they form directly the basis for the conclusions drawn, these values should be placed under the heading "Results". Tabular forms or graphs are used if the results are lengthy and/or comparisons are to be made.

Graphs are important visual aids for presenting and comparing data and results. They are so widely used that every student should master the techniques required for their proper preparation. A list of some of the more important considerations follows:

The graph should be headed by a descriptive heading.

The coordinate axes should be labeled and scales so chosen that the major division lines represent whole numbers. If values read from the curves are to be used either for computation purposes or as results, the scales should be made large enough so that these values can be read to a degree of precision consistent with the test data.

Plotted values may be indicated by the use of circles, crosses, etc. (using a different symbol of each curve). If a number of curves are plotted on the same sheet, each curve should be identified separately. Occasionally, a legend may help to avoid confusion.

Dashed lines should be used for those portions of the curves that are not depicted by the test data.

Important points on the graph should be clearly designated. Notes may be used whenever their inclusion help make the graph self-explanatory.

The curves should be centered on the sheet and oriented in the correct position for binding in to the report.

Curves are made smooth in outline whenever the data represent continuous functions. In such instances, the curves represent a statistical average of the observed or computed values. Points

on either side of a curve indicate errors in the observations, variations of the test conditions, inaccurate computations, and the like. Most graphs representing engineering data are of this nature, but there are cases when depicting the statistical average (or trend) is not the significant function of the curve. For example, a curve may be plotted to show the variation in volume of production. Each rise or fall in the daily (or weekly, etc.) volume of production will have its own story to tell. Hence, straight lines joining the plotted points would be more significant than a smooth curve that indicates the trend.

Discussion of Results: This topic is reserved for the individual's evaluation of the validity of the results, for statements of other facts, for comparisons, and for the reasoning that led to the formation of the conclusions. The modern trend in the design of experiments is to rely increasingly on the statistical concepts as a basis for determining what confidence can be placed in the results. Whenever possible the degree of uncertainty should be formulated on the mathematical basis.

It may be necessary to modify an accepted procedure to meet a peculiar need; or something may go wrong with the apparatus or the specimen during the test. These occurrences should be recorded, but their effect on the validity of the results evaluated.

The acceptance or rejection of the conclusions drawn in the report is directly related to the skill of the reported in providing an accurate and convincing discussion of the reasoning upon which the conclusions are based. The discussions of the results generally affords the basis for fruitful discussion of difference of opinion between the writer and his reader.

Appendices: Appendices should include curves that are not specific results, lengthy mathematical derivations, special procedures, and all other extraneous material that does not fit into the suggested topics or that would break the continuity of the report.

Bibliography: The report should include a bibliography of the source material used in this preparation. Where material is extracted bodily or merely paraphrased it should be placed in quotation marks and direct reference made to its source. Extensive quotes are undesirable. It is suggested that the reference material be studied with a view towards crystallizing the salient concepts pertinent to the problem at hand, and proper credit given to the sources from which the information has been obtained. An example of an entry should follow the following format:

Casagrande, A. (1932), "Research of Atterberg Limits of Soils," *Public Roads*, Vol. 13, No. 8, 121-136.

Participation: A separate page should be set aside to include the group number, date of experiment, and the members in each laboratory group. Each name should be followed by what each member did.