Proceedings of the Iowa Academy of Science

Volume 65 | Annual Issue Article 46

1958

Further Studies of Loess in Iowa: Thickness, Clay Content, and Engineering Classification

J. A. Hansen Jr.
Iowa State College

A. R. Dahl
Iowa State College

D. T. Davidson
Iowa State College

Further Studies of Loess in Iowa: Thickness, Clay Content, and Engineering Classification

By J. A. Hansen, Jr., A. R. Dahl, and D. T. Davidson[1]

Introduction

This paper is a continuation of the work previously reported by Dahl, Handy and Davidson (1), and summarizes currently available information on properties of the Wisconsin loess. New areas of investigation are in northwest and eastern Iowa.

Depth measurements and samples in the bluffs region were obtained mostly from the traverses of Hutton (2) and Davidson, et al. (3). Riggs (4) continued these traverses and the northwest-southeast traverses of Lyon, et al. (5), and established a grid-like sample pattern in southwest Iowa. Dahl (6) and Hansen (7) extended the grid eastward to the Mississippi River. Data on northwest Iowa was obtained from the east-west traverses initiated by Davidson (8).

Loess Thickness

A tentative map of Wisconsin loess thickness in western, southern, and eastern Iowa is shown in figure 1. From this map it is apparent that two areal distribution patterns in western Iowa are separated by the border between the Iowan-Tazewell and Kansan drift sheets. Loess thickness which is significantly greater south of this drift border, reaches a maximum depth of over 150 feet immediately adjacent to the Missouri River floodplain. North of the drift border, adjacent to the Big Sioux River, the maximum depth of the loess is only about 25 feet. Because of the differences in the two areas, no attempt has been made to connect thickness contours.

Figure 1 indicates a major thinning trend of the loess eastward from the Missouri River floodplain. In eastern Iowa there is a second thinning trend in which loess diminishes to the north and south of a contoured high located near the approximate terminus of the Iowan drift.

[1]Research Assistant, Associate in Civil Engineering, and Professor of Civil Engineering, respectively, Engineering Experiment Station, Iowa State College, Ames, Iowa.

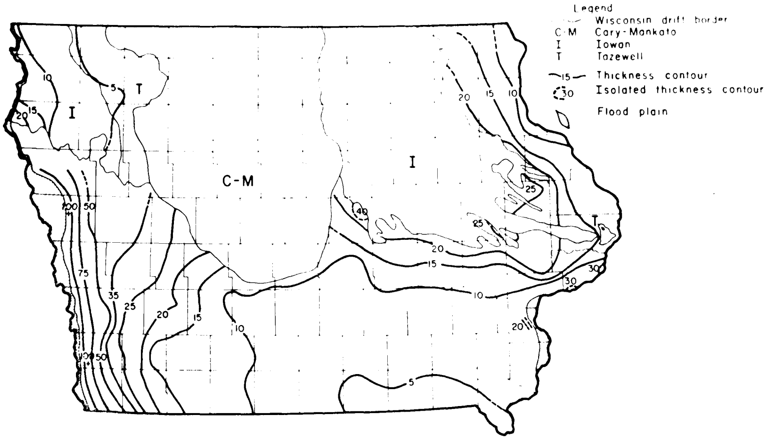

Figure 1. Map showing thickness of Wisconsin loess.

Clay Content

The percent of minus 5 micron clay in the C-horizon loess is shown in Figure 2.[2] Clay content increases eastward from the Missouri River and is at a maximum in south-central Iowa. Clay content decreases to the northeast from the maximum area shown by the 45 percent contour, reaching a minimum within the 20 percent contour. North and east of this area, clay content again increases toward the Mississippi River.

From a comparison of figures 1 and 2, a generalization may be made that as loess thickness decreases, clay content increases. (Figure 4). This seems to agree with previous investigations conducted by Davidson, et al., (9), Simonson, et al., (10), and Ruhe, (11).

Maps

Both the loess thickness and clay content maps must be considered as tentative although nearly 200 sample sites were analyzed for each. Few samples have been obtained within the area of the Iowan drift east of the Cary-Mankato lobe. Since contour accuracy depends on the frequency of control, occasionally it becomes necessary to locate approximate boundaries by means of dashed lines.

Ruhe (11) has shown that loess thickness varies significantly with respect to topographic position, commonly thinning below crests of divides in an east-west direction. Primary consideration was given to data representing sample sites known definitely to be located at or near the crest of topographic highs. Equal importance was at-

[2]Analyses by hydrometer method (ASTM Designation D 422-54T)

tached to sample locations designated or observed to be located on the very flat terrain of the uplands. It is hoped that erosion effects may be reduced by the use of samples so chosen.

Engineering Classification

Classification of the loess for engineering purposes is indicated in figure 3 following the standards of the American Association of Highway Officials (12). Samples representing C-horizon loess were obtained at depths which ranged from around 60 feet near the bluffs bordering the Missouri River flood plain to as little as two to four feet in south-central Iowa.

Seven major soil groups have been proposed by the AASHO. As indicated by figure 3, loess falls into the A-4, A-6, and A-7 groups. The general description of the A-4, A-6, and A-7 groups is as follows:

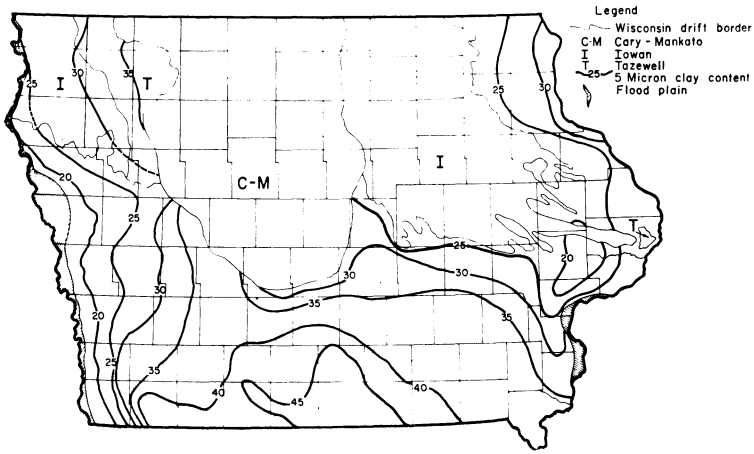

Figure 2. Map of Wisconsin loess clay content.

Group A-4. This group contains nonplastic or moderately plastic silty soil usually having 75 percent or more passing the No. 200 sieve (74 microns). Mixtures of fine silty soil and up to 64 percent of sand and gravel retained on the No. 200 sieve are also included.

Group A-6. Group A-6 contains plastic clay soils usually having 75 percent or more passing the No. 200 sieve. Mixtures of fine clayey soil and up to 64 percent of sand retained on the No. 200 sieve are included.

Group A-7. Plastic clay soils similar to those in Group A-6, but having higher liquid limits, make up Group A-7. The soils may occasionally be elastic as well as subject to high volume changes.

Soils of several major groups are subdivided on the basis of texture, liquid limit, and plasticity index. All groups are further divided by means of a numerical group index, a feature intended to place a relative index of performance upon individual soils within a group. In this report, only the major group designations are used.

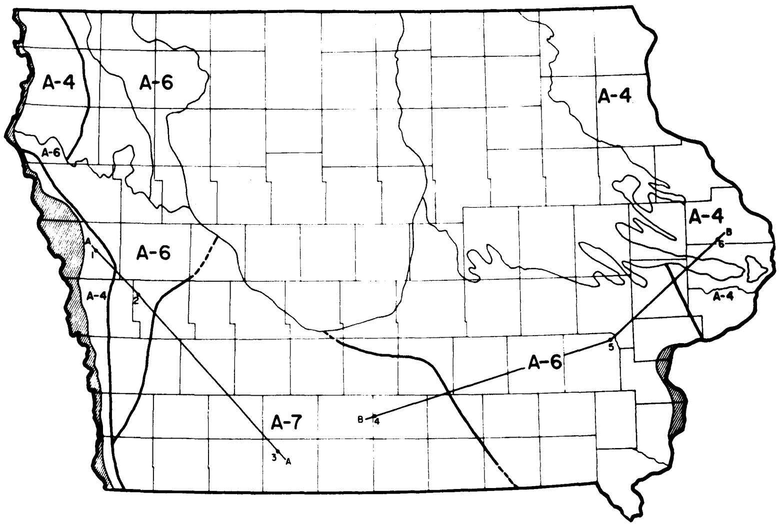

Figure 3. Map showing engineering classification of Wisconsin loess. Note traverses A-A and B-B.

Clay content has a direct relation to plasticity (13, 14). In western Iowa in the narrow band which parallels the flood plain, clay content is 25 percent or less, and the plasticity index of most samples is less than 10. These samples are included in the A-4 group. As clay content increases, the plasticity index usually is greater than 10. This area is shown by the A-6 band. Proceeding further east and southeast the clay content reaches a maximum (see figures 2 and 4) and it is within the area designated A-7 that liquid limits and plasticity indices are greatest. Samples obtained in southeast Iowa indicate a second broad A-6 area extending towards the Mississippi River.

Acknowledgments

The subject matter of this report was obtained as part of the research being done under Project 283-S of the Engineering Experiment Station of the Iowa State College. This project entitled, "The Loess and Glacial Till Materials of Iowa; an Investigation of Their Physical and Chemical Properties and Techniques for Processing Them to Increase Their All-Weather Stability for Road Construction," is being carried on under contract with the Iowa Highway Research

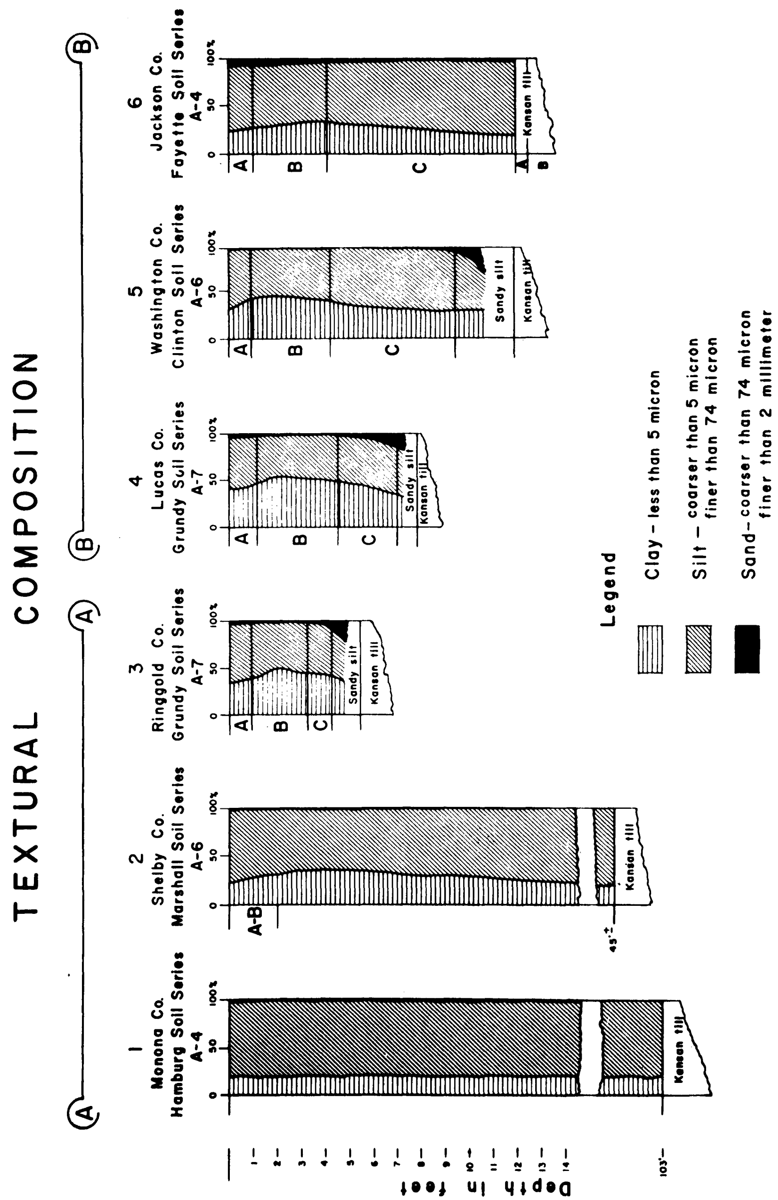

Figure 4. Textural composition of six loess samples with depth obtained along traverses A-A and B-B, showing relationship of loess thickness to clay content and engineering classification.

Board (Project No. HR-1) and is supported by funds supplied by the Iowa State Highway Commission and the United States Bureau of Public Roads.

Literature Cited

1. Dahl, A. R., Handy, R. L., and Davidson, D. T. 1957. Variation of loess thickness and clay content in southern Iowa. Iowa Acad. Sci. Proc. 64: 393-399.
2. Hutton, C. E. 1948. Studies of loess-derived soils in southwestern Iowa. Proc. Soil. Sci. Soc. Am. 12:424-431.
3. Davidson, D. T., Handy, R. L., and Chu, T. Y. 1953. Depth studies of the Wisconsin loess in southwestern Iowa: I. Particle-size and in-place density. Iowa Acad. Sci. Proc. 60:333-353.
4. Riggs, K. A., Jr. 1956. Pleistocene geology and soils in southern Iowa. Ph.D. thesis, Iowa State College Library, Ames, Iowa.
5. Lyon, C. A. 1955. Petrography of four northeastern Iowa loess samples. M.S. thesis, Iowa State College Library, Ames, Iowa.
6. Dahl, A. R. Petrography of till and loess, south-central Iowa. M.S. thesis, Iowa State College. (In preparation).
7. Hansen, John A., Jr. Geologic and engineering properties of loess and till, southeast Iowa. M.S. thesis, Iowa State College. (In preparation).
8. Davidson, D. T. Unpublished data. Engineering experiment Station, Iowa State College, Ames, Iowa.
9. Davidson, D. T., and Handy, R. L. 1952. Property variations in the Peorian loess of southwestern Iowa. Iowa Acad. Sci. Proc. 59:248-265.
10. Simonson, R. W., Rieken, F. F., and Smith, G. D. 1952. Understanding Iowa Soils. Dubuque, Iowa, Wm. C. Brown Company.
11. Ruhe, R. V. 1954. Relations of the properties of Wisconsin loess to topography in western Iowa. Amer. Jour. Sci. 252:663-672.
12. American Association of State Highway Officials. 1950. Standard Specifications for highway materials and methods of sampling and testing, Part I. Specifications. The Association, Washington, D. C.
13. Davidson, D. T. and Handy, R. L. 1953. Studies of the clay fraction of southwestern Iowa loess.
14. Sheeler, J. B. and Davidson, D. T. 1957. Further correlation of consistency limits of Iowa loess with clay content. Iowa Acad. Sci. Proc. 64:407-417.

IOWA ENGINEERING EXPERIMENT STATION
IOWA STATE COLLEGE
AMES, IOWA