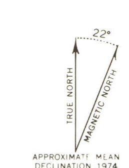
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

FOLIO OF KING COUNTY, WASHINGTON
MAP I-852-C

Base from U.S. Geological Survey, 1:24,000
Olalla, 1953, Vashon, Des Moines, Renton,
and Maple Valley, 1949
Photorevision as of 1968



SCALE 1:48 000

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

CONTOUR INTERVAL 25 FEET
(EXCEPT IN WESTERN VASHON ISLAND, WHERE
THE CONTOUR INTERVAL IS 20 FEET)
DATUM IS MEAN SEA LEVEL
SHORELINE SHOWN REPRESENTS THE APPROXIMATE
LINE OF MEAN HIGH WATER
THE AVERAGE RANGE OF TIDE IS APPROXIMATELY 11-12 FEET

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1974

Interpretation based on maps and reports by Vine (1962), Waldron (1962), Mullineaux (1965; 1970), Molenaar (1965), Luzier (1969), U.S. Soil Conservation Service, and U.S. Dept. of Agr., (1952), and discussions in 1973 with D. R. Mullineaux, H. W. Olsen, and H. H. Waldron, U.S. Geol. Survey, and E. R. Artim, Washington (State) Div. of Mines and Geology

EXPLANATION

I

Class I
Virtually noncompressible
Areas underlain by bedrock

IIa IIb

Class II
Virtually noncompressible to slightly compressible
Areas underlain by dense surficial deposits (overridden by glacial ice)

Class IIa: Coarse- to fine-grained dense materials
Class IIb: Coarse- to fine-grained dense materials, but higher in silt and clay than class IIa

IIIa IIIb

Class III
Slightly to moderately compressible
Areas underlain by surficial materials (not overridden by glacial ice)

Class IIIa: Largely coarse-grained deposits, probably low in silt and clay
Class IIIb: Fine-grained deposits, sand, silt, and clay

IVa IVb

Class IV
Highly compressible
Areas underlain by deposits rich in organic matter (not overridden by glacial ice)

Class IVa: Sand, silt, clay, and some peat in layers and as random fragments; high moisture content
Class IVb: Peat, sandy, silty; generally saturated

PURPOSE

This map classifies part of west-central King County, Washington, into areas of differing relative compressibilities. Compressibility is a natural property of earth materials which is related to decrease in volume; where arbitrarily assigned values are low, such values may be indicative of poor foundation stability. Knowledge of the distribution of areas of differing compressibility can be valuable in determining suitability for various land uses.

Geologic deposits in this part of the Puget Sound lowland are grouped into four classes of relative compressibility, and their distribution is shown on the map. The classes are hard rock, considered to be virtually noncompressible (class I); surficial deposits, believed to be virtually noncompressible to slightly compressible (class II); surficial deposits, believed to be slightly to moderately compressible (class III); and surficial deposits, known to be highly compressible (class IV). Classes II, III, and IV are divided into subclasses on the basis of probable differences in grain size, which controls porosity and affects the capacity of the particles to either retain or transmit moisture.

Not shown on the map are areas of compressibility classes too small to be indicated at this scale and so thin that the information on which they would be based is not shown on the geologic source maps. Also not differentiated is land that has been extensively modified by man, such as large excavations and fills which expose deposits not indicated on geologic maps or which obscure mapped deposits.

The map was compiled from data collected by other investigators (see references) without supplementary field studies; consequently, it should not be used to evaluate specific sites. Examination of published descriptions of geologic deposits and discussions with geologists who have worked in the Puget Sound lowland concerning compressibility of certain materials led me to use grain size, estimated porosity, and content of organic material as the most critical physical properties from which to infer potential compressibility. Standard-penetration-test data (fig. 1), obtained from various sources, support interpretations based on other physical properties and the geologic history of the deposits.

DESCRIPTION OF RELATIVE COMPRESSIBILITY CLASSES

Compressibility refers to the property of earth materials pertaining to their susceptibility to decrease in volume when subjected to loads (Am. Soc. for Testing and Materials, 1973, p. 286). An important factor controlling compressibility is grain size; fine-grained deposits with a high degree of porosity have a greater potential for compaction than do coarse-grained deposits. In western King County, the degree of compressibility is related to geologic history; deposits that were formed before the last glaciation were subject to volume loss induced by the weight of several thousand feet of glacial ice. The compressibility classes are as follows:

Class I: Characterized by areas underlain by bedrock. Several different types of rock are included; most consist of hard dense and virtually noncompressible rock. Areas of class I occur in the mountains in the northeastern part of the mapped area and along the Duwamish Valley and Cedar River valley.

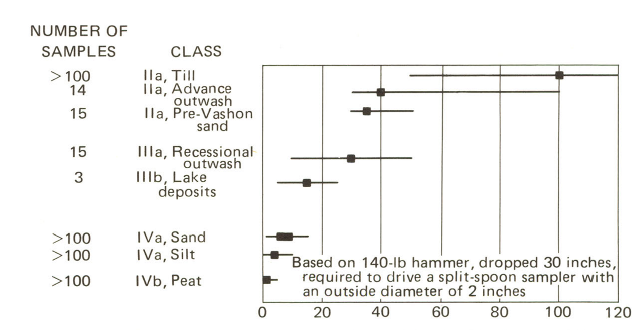


FIGURE 1. – Standard-penetration resistance of several deposits grouped in compressibility classes II, III, and IV. Length of line indicates the range in number of blows recorded during test in each geologic deposit. Solid rectangles indicate the average number of blows for the deposits tested and reflect variations in density between materials in different classes and, probably, their differences in compressibilities. Test data collected and compiled by Ernest R. Artim, Washington [State] Division of Mines and Geology.

Class II: Characterized by unconsolidated deposits that have low porosity and that may be almost as noncompressible as class I. These deposits have been overridden by as much as 3,000 feet of glacial ice. The weight of the ice compacted normally loose and soft deposits into harder and denser deposits. Class II areas are separated into subclasses on the basis of the difference in grain sizes of deposits that is believed to cause slight variation in compressibility. Class IIa areas, largely in the uplands, are underlain by dense deposits generally composed of coarse- to fine-grained materials that probably have very low porosities (fig. 1). Class IIb areas, mostly along Cedar River valley, sea cliffs facing Puget Sound, and small isolated areas elsewhere, are underlain by dense coarse- to fine-grained deposits believed to be higher in silt and clay content than class IIa; test data are not available for this subclass.

Class III: Characterized by unconsolidated deposits that are normally looser, softer, and seem to be more easily penetrated than those in class II (fig. 1). These deposits were not overridden by glacial ice, although some accumulated on or against parts of the glacier; others were formed after the ice had disappeared from the area.

Class III areas also are separated into subclasses on the basis of variation in grain sizes that presumably produce differences in porosity and, correspondingly, compressibility (fig. 1). Class IIIa areas coincide with former glacial melt-water channels cut in the uplands, and with modern valleys and beaches. They are underlain largely by coarse-grained deposits that are low in silt and clay. Class IIIb areas include lakes and ponds on upland surfaces, glacially blocked valleys, and landslides along valley walls. In general, these areas are underlain almost exclusively by sand, silt, and clay which are believed to have high porosities.

Most of the deposits in Class III areas probably have been subjected to numerous earthquakes and to many cycles of wetting and drying. These repeated effects may have caused some loss of volume and an increase in density of the deposits. Consequently, their potential compressibility may have been reduced somewhat since initial deposition. Nevertheless, they are more compressible than materials overridden by the glacial ice (fig. 1).

Class IV: Characterized by unconsolidated deposits, not overridden by ice, composed of sand, silt, and clay deposits rich in organic matter that are judged to be compressible (fig. 2). These deposits have an extremely high moisture-retention capability because of their organic content. Class IVa, which is restricted to the Duwamish Valley, commonly is underlain by mixtures of sand, silt, and clay that contains, or is interlayered with, peat.

Class IVb areas include small to large depressions and lake basins on the upland, within old melt-water channels, and on modern valley floors. Deposits are predominantly sandy, silty peat and are generally saturated. The extremely high organic content and the saturation make this class more compressible than class IVa (fig. 2).

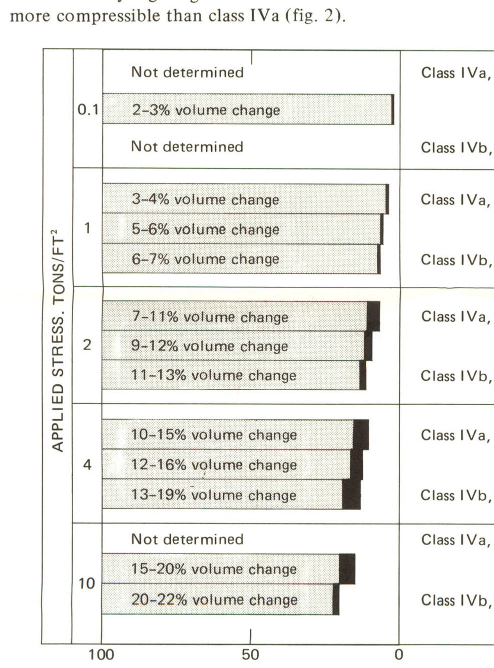


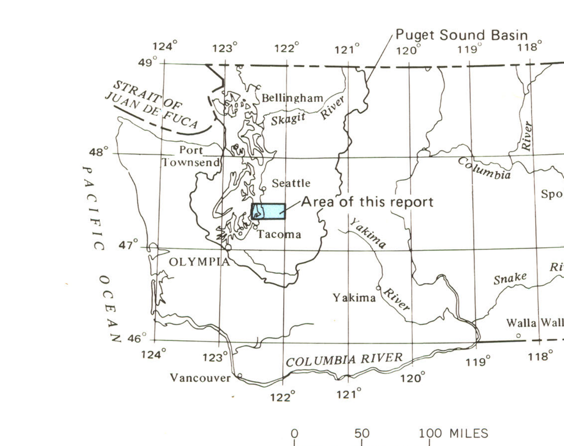
FIGURE 2. – Percentage of volume change of materials characteristic of class IV areas when subjected to varying stresses. Samples were selected from 3-foot depths. Thickness of solid box at the end of each column reflects the range in percent of loss of volume for samples tested. Test data collected and compiled by Ernest R. Artim, Washington [State] Division of Mines and Geology.

ENGINEERING SOLUTIONS FOR SETTLEMENT CAUSED BY COMPRESSIBILITY

Typical solutions used to prevent settling of highly compressible foundation materials, such as in class IV, are (1) overloading to induce consolidation by excessive compression before construction, and (2) driving piles to less compressible deposits at depth.

Preconsolidation techniques generally involve placing enough earth fill on the proposed site to exceed the design-weight of the planned structure. The loads remain in position until settlement stops and the ground stabilizes. Material equivalent to the weight of the planned building is then removed, and the structure is subsequently built on the remaining fill, replacing the load and maintaining an overloaded condition.

Clusters of piles or concrete-filled caissons are also used under some conditions to provide stable foundations. The bearing capacity of driven piles depends on the friction between the sides of the piles and the geologic materials, or on the presence of a resistant layer to which the piles are driven. Concrete-filled caissons generally transfer the weight of the structures downward to stable materials.



MAP OF WASHINGTON

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MAP SHOWING RELATIVE COMPRESSIBILITY OF EARTH MATERIALS IN PART OF WEST-CENTRAL KING COUNTY, WASHINGTON

By
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1974

For sale by U.S. Geological Survey
Denver, Colo. 80225 and Reston, Va. 22092, price 75 cents