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CRUTCHFIELD,D. Operating Reactors Branch 5

SUBJECT: Responds to 820219 ltr re SEP Topic II.4.D,stability of slopes.Calculation of internal friction angle & factor of safety & addl boring logs encl.

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JOHN E. MAIER
Vice President

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March 10, 1982

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US NUCLEAR REGULATORY COMMISSION
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Director of Nuclear Reactor Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: SEP Topic II-4.D, Stability of Slopes
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Crutchfield:

This submittal is in response to your letter of February 19, 1982 concerning the subject topic. In the NRC's evaluation, no conclusion could be made relative to the stability of slopes on the Ginna site, since soil property test results were not supplied by RG&E.

In the attached evaluation, a conservative calculation of the internal friction angle of the silty clay soil is made, based on direct shear tests made on the actual soil samples taken from boring #1. Using the results of this calculation, which resulted in an internal friction angle of 14°, the factor of safety is calculated to be about 1.9, which is greater than the Standard Review Plan acceptance criteria of 1.5. The stability of slopes on the Ginna site is thus assured.

It should be noted that the boring logs transmitted to the NRC as an attachment to RG&E's January 15, 1982 submittal on this topic were taken from a preliminary report, which showed shear strength values lower than those finally calculated, and presented in the R. E. Ginna Preliminary Safety Analysis Report (PSAR). The boring logs for boring #1 and boring #3 are also being transmitted with this submittal.

Finally, additional boring information was found, which was performed in 1974 by Dames and Moore in the "Subsurfaces Investigation, Proposed Ginna Auxiliary Building Addition, R. E. Ginna Nuclear Power Plant-Unit No. 1, Ontario, New York, Rochester Gas and Electric Corporation." Although the soil test records are not

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available for review, the conclusions stated in this report note that ". . .it is our [Dames and Moore] opinion that the following soil properties should be used for analysis of safety-related structures [at the Ginna site]...

ϕ = 38° (Effective Internal Friction)
C = 0 (Effective Cohesion)

These properties are in keeping with conservative practices associated with safety-related nuclear facilities."

These recommendations compare reasonably well with the recommendations stated in RG&E's January 15, 1982 submittal.

Based on this information and the conservative evaluation of internal friction angle provided in the attachment, it should be concluded that the slopes on the R. E. Ginna site are not of safety concern.

Very truly yours,

John E. Maier

Attachment

Attachment: Calculation of Internal Friction Angle and Factor of Safety for SEP Topic II-4.D, Stability of Slopes, R. E. Ginna

Two onsite slopes have been identified at the R. E. Ginna Plant whose failure may be of safety concern. The subsurface conditions beneath these two slopes have been acceptably identified as the same conditions revealed by Boring #1 and Boring #3 of the boring program data submitted in the PSAR for the R. E. Ginna Plant. The stratum that is the focus of primary concern in the slope stability analysis has been designated as a CL class material. The CL material taken from Boring #1 was submitted to two Direct Shear Tests to determine necessary soil properties. The results of these tests can be seen on the copy of Boring Log #1 attached to this submittal. A copy of the method of performing these direct shear tests is also attached.

In the first test, a constant normal pressure, σ, of 1,000 pounds per square foot was applied, the sample was subjected to direct double shear forces, and shearing failure was achieved at the ultimate shear strength, τ, of 250 pounds per square foot. In the second test, the constant normal pressure, σ, was increased to 2,000 pounds per square foot, direct double shear was applied, and the sample failed at the ultimate shear strength, τ, of 600 pounds per square foot. In the direct shear test, only the normal and shear stresses on a single plane alone are known. Hence, from the test results alone, it is not possible to draw the Mohr circle giving the state of stresses. However, if we make the assumption that the measured stresses at failure are in the ratio $\tau/\sigma = \tan \phi$, then it is possible to construct the Mohr circle. In effect, we have assumed that the horizontal plane through the shear box is identical with the theoretical failure plane. . .* It should also be noted that any positive effect that cohesion of the soil will have on increasing the internal angle of friction has not been considered in this analysis.

The analysis of an effective internal resistance angle in this report is a decidedly conservative evaluation due to the fact that the direct shear test results are a measure of the shear stresses only on the horizontal plane with no other planes considered. The normal stress, σ, and the ultimate shear strength, τ, for each of the two tests were used to generate a worst case failure plane using Mohr's circle (see Figure 1). The effective internal resistance angle using this very conservative method, is found to be 14°.

* See page number 142, reference #7 of 6/30/81 assessment.

The factor of safety can now be calculated:

$$F_s\text{, Factor of Safety} = \frac{\tan \phi}{\tan \phi'}$$

Where ϕ is the internal angles of resistance of the soil at ultimate strength and ϕ' is developed internal angle of resistance of the soil in its equilibrium state. With the steepest angle of reponse, ϕ', found on site to be 7.5 feet horizontal to 1 foot vertical, then $\tan \phi' = 1 \text{ ft}/7.5 \text{ ft} = 0.133$. Thus, a very conservative factor of safety can be calculated, as follows:

$$F_s = \frac{\tan 14°}{0.133} = \frac{0.249}{0.133} = 1.875 \text{ or } 1.9$$

The safety factor of 1.9 is above the safety factor of 1.5 recommended for the stability of slopes in the Standard Review Plan.

[illegible]

[illegible]

[illegible]

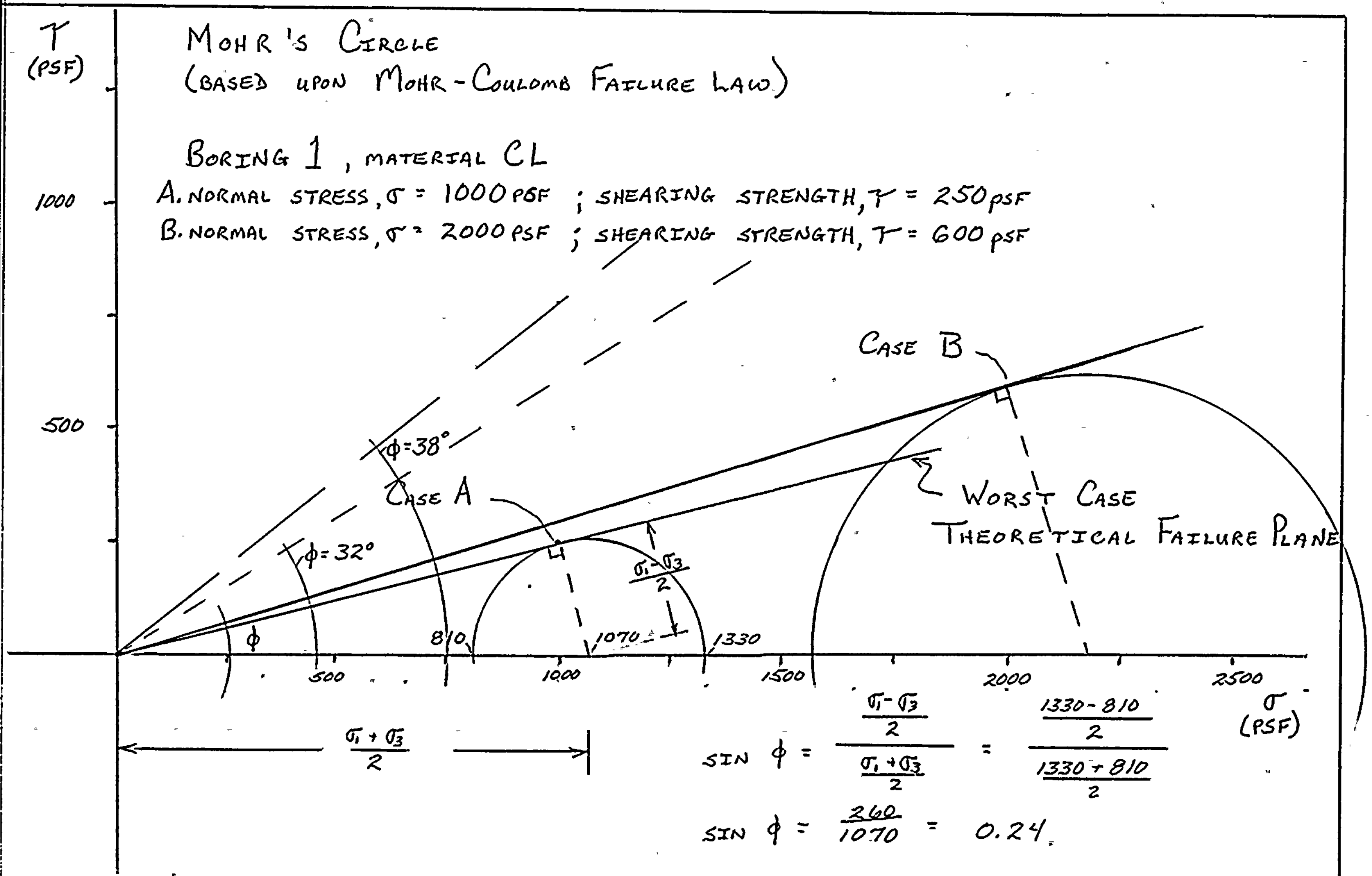
[illegible]

MOHR'S CIRCLE
(BASED UPON MOHR-COULOMB FAILURE LAW)

BORING 1, MATERIAL CL

A. NORMAL STRESS, σ = 1000 PSF ; SHEARING STRENGTH, τ = 250 psf

B. NORMAL STRESS, σ = 2000 PSF ; SHEARING STRENGTH, τ = 600 psf

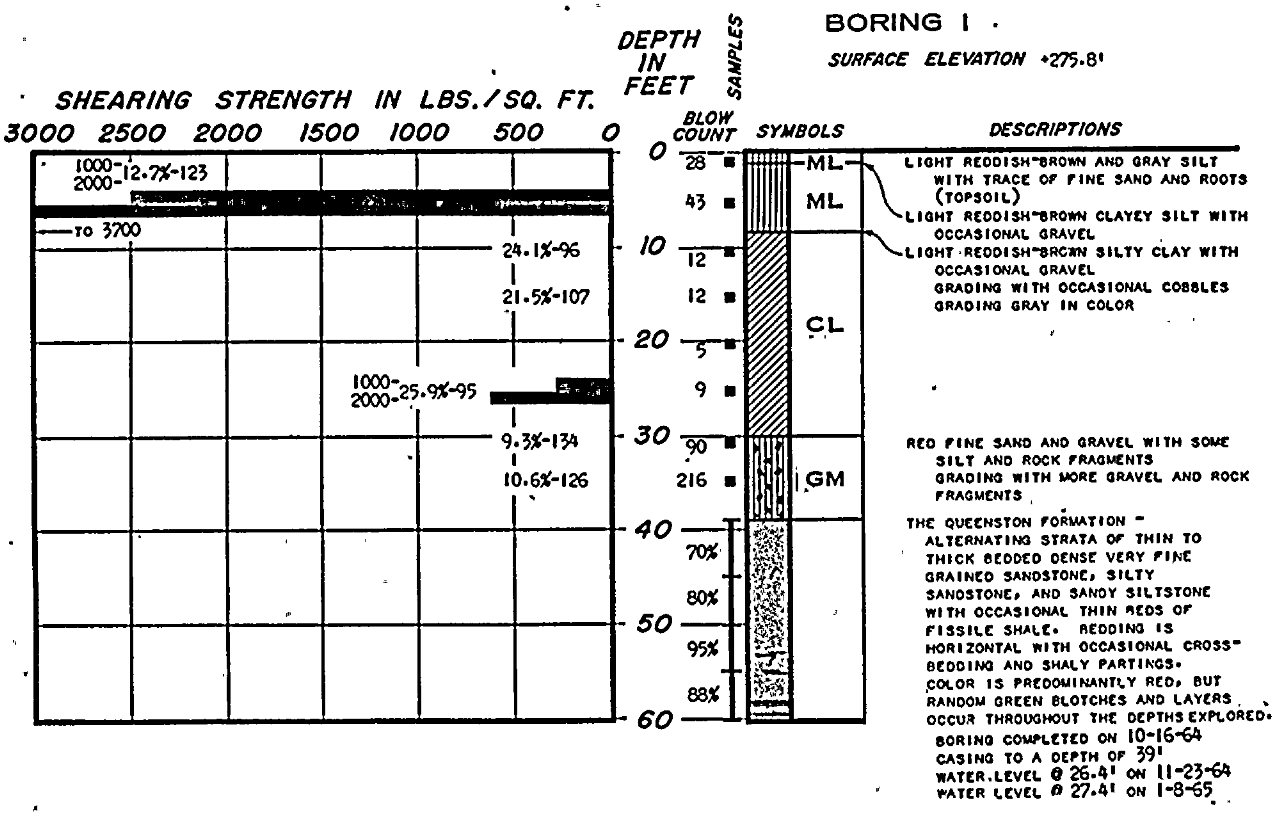


$$\sin\phi = \frac{\frac{\sigma_1-\sigma_3}{2}}{\frac{\sigma_1+\sigma_3}{2}} = \frac{\frac{1330-810}{2}}{\frac{1330+810}{2}}$$

$$\sin\phi = \frac{260}{1070} = 0.24$$

$$\phi = 14.0^\circ$$

SOURCE OF INFORMATION - ROCHESTER GAS & ELECTRIC CORPORATION
BROOKWOOD (GINNA) NUCLEAR STATION UNIT No. 1
PRELIMINARY FACILITY DESCRIPTION AND
SAFETY ANALYSIS REPORT



KEY TO ROCK SYMBOLS:

- QUEENSTON FORMATION
- QUEENSTON FORMATION WITH SHALY PHASES
- QUEENSTON FORMATION WITH VERTICAL FRACTURES

LOG OF BORING

NOTES:

THE FIGURES UNDER THE COLUMN LABELED "BLOW COUNT" INDICATE:

1) THE NUMBER OF BLOWS REQUIRED TO DRIVE THE DAMES & MOORE SOIL SAMPLER A DISTANCE OF ONE FOOT INTO THE OVERBURDEN USING 500-LB. SLIP-JARS FALLING A DISTANCE OF 18 INCHES. THE SAMPLER IS 3¼" O.D. AND 2½" I.D.

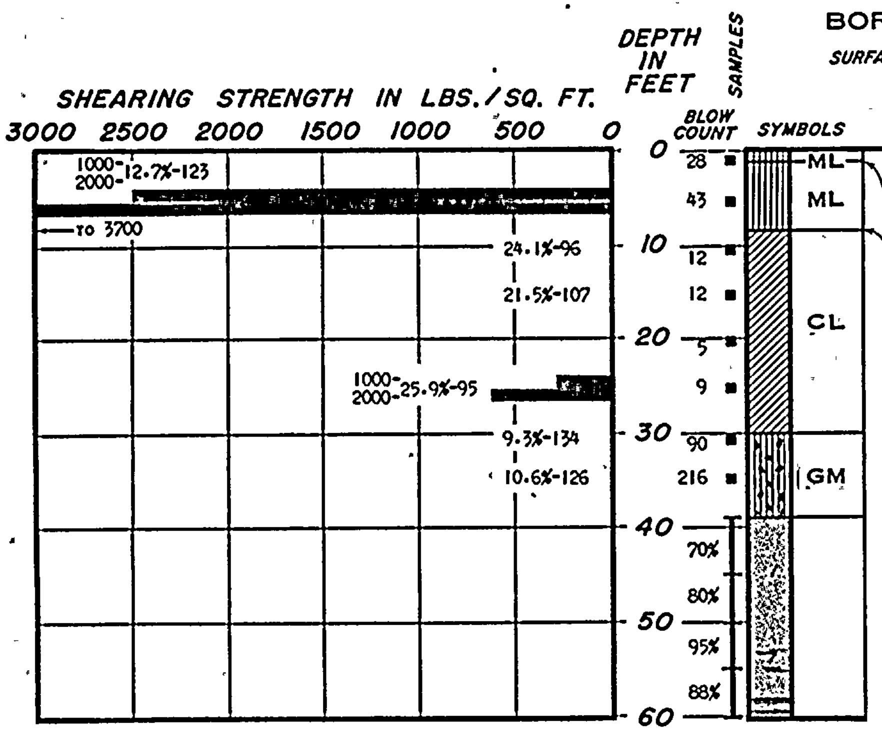
2) THE PERCENT OF CORE RECOVERED IN A CORING RUN IN ROCK. AN NX-SIZE DOUBLE TUBE CORE BARREL WAS USED TO CORE ROCK.

SURFACE ELEVATIONS REFER TO USC&GS DATUM.

DAMES & MOORE

BORING 1

SURFACE ELEVATION +275.8'



LIGHT REDDISH-BROWN AND GRAY SILT WITH TRACE OF FINE SAND AND ROOTS (TOPSOIL)

LIGHT REDDISH-BROWN CLAYEY SILT WITH OCCASIONAL GRAVEL

LIGHT REDDISH-BROWN SILTY CLAY WITH OCCASIONAL GRAVEL
GRADING WITH OCCASIONAL COBBLES
GRADING GRAY IN COLOR

RED FINE SAND AND GRAVEL WITH SOME SILT AND ROCK FRAGMENTS
GRADING WITH MORE GRAVEL AND ROCK FRAGMENTS

THE QUEENSTON FORMATION - ALTERNATING STRATA OF THIN TO THICK BEDDED DENSE VERY FINE GRAINED SANDSTONE, SILTY SANDSTONE, AND SANDY SILTSTONE WITH OCCASIONAL THIN BEDS OF FISSILE SHALE. BEDDING IS HORIZONTAL WITH OCCASIONAL CROSS-BEDDING AND SHALY PARTINGS. COLOR IS PREDOMINANTLY RED, BUT RANDOM GREEN BLOTCHES AND LAYERS OCCUR THROUGHOUT THE DEPTHS EXPLORED.

BORING COMPLETED ON 10-16-64
CASING TO A DEPTH OF 39'
WATER LEVEL @ 26.4' ON 11-23-64
WATER LEVEL @ 27.4' ON 1-8-65

KEY TO ROCK SYMBOLS:

- QUEENSTON FORMATION
- QUEENSTON FORMATION WITH SHALY PHASES
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LOG OF BORING

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2) THE PERCENT OF CORE RECOVERED IN A CORING RUN IN ROCK. AN NX-SIZE DOUBLE TUBE CORE BARREL WAS USED TO CORE ROCK.

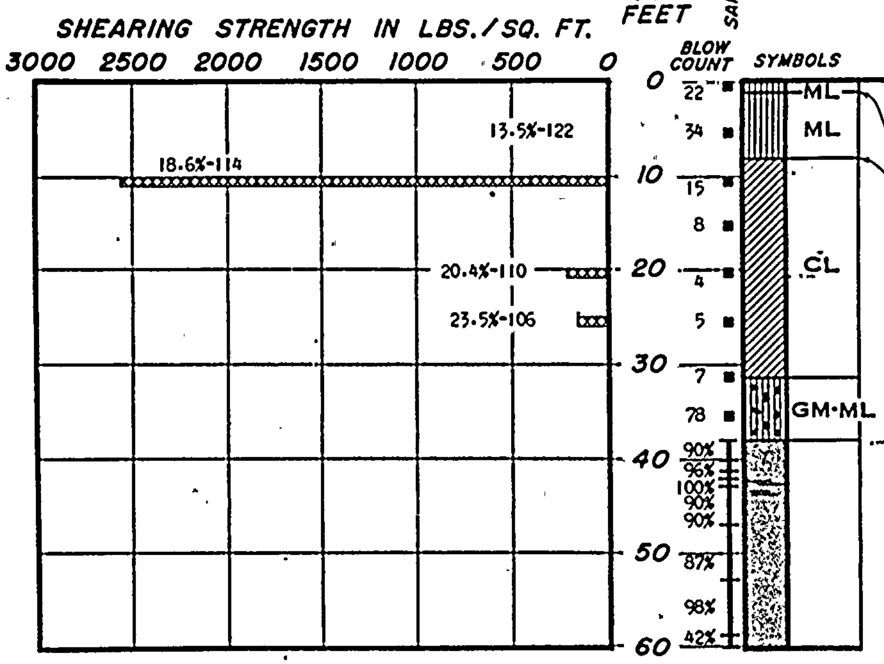
SURFACE ELEVATIONS REFER TO USC&GS DATUM.

DAMES & MOORE

FILE 4774-001

BORING 3

SURFACE ELEVATION +27?.0'



DESCRIPTIONS

LIGHT REDDISH-BROWN AND GRAY SILT WITH TRACE OF FINE SAND AND ROOTS (TOPSOIL)

BROWNISH-GRAY CLAYEY SILT WITH SOME FINE TO MEDIUM GRAVEL

BROWNISH-GRAY SILTY CLAY WITH SOME FINE SAND AND OCCASIONAL GRAVEL

GRADING WITH LENSES OF GRAY FINE SAND

GRADING WITH LESS SAND AND GRAVEL

RED FINE SANDY SILT WITH SOME GRAVEL AND ROCK FRAGMENTS

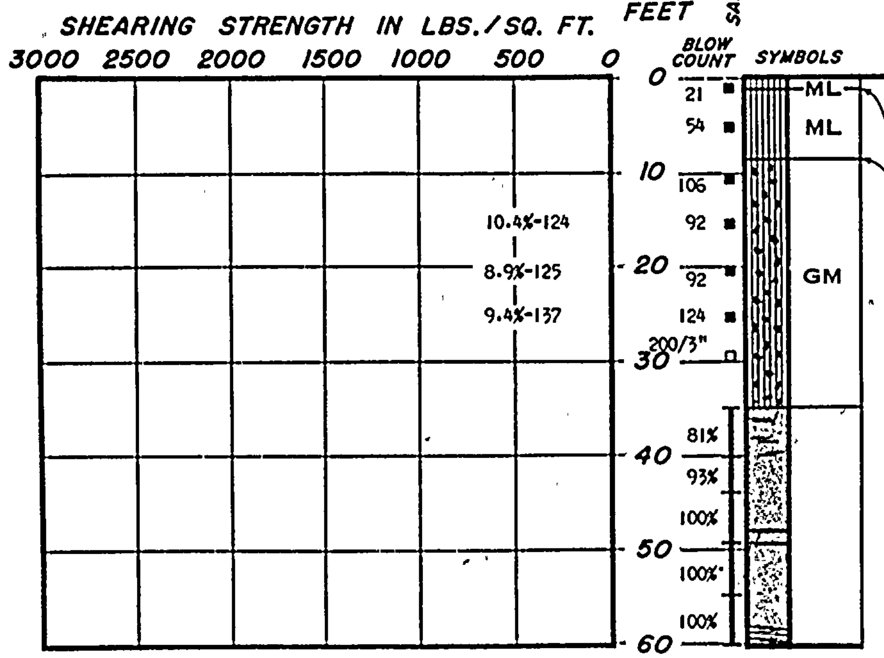
GRADING WITH MORE GRAVEL AND SHALE FRAGMENTS

THE QUEENSTON FORMATION - ALTERNATING STRATA OF THIN TO THICK BEDDED DENSE VERY FINE GRAINED SANDSTONE, SILTY SANDSTONE, AND SANDY SILTSTONE WITH OCCASIONAL THIN BEDS OF FISSILE SHALE. BEDDING IS HORIZONTAL WITH OCCASIONAL CROSS-BEDDING AND SHALY PARTINGS. COLOR IS PREDOMINANTLY RED, BUT RANDOM GREEN BLOTCHES AND LAYERS OCCUR THROUGHOUT THE DEPTHS EXPLORED.

BORING COMPLETED ON 10-19-64
CASING TO A DEPTH OF 38'
WATER LEVEL @ 25.8' ON 11-23-64
WATER LEVEL @ 25.3' ON 1-9-65

BORING 4

SURFACE ELEVATION +278.5'



DESCRIPTIONS

LIGHT REDDISH-BROWN AND GRAY SILT WITH TRACE OF FINE SAND AND ROOTS (TOPSOIL)

REDDISH-BROWN AND GRAY CLAYEY SILT WITH OCCASIONAL GRAVEL

REDDISH-BROWN SILTY FINE SAND AND GRAVEL WITH SHALE FRAGMENTS

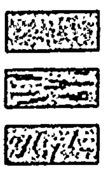
GRADING WITH MORE SILT

THE QUEENSTON FORMATION - ALTERNATING STRATA OF THIN TO THICK BEDDED DENSE VERY FINE GRAINED SANDSTONE, SILTY SANDSTONE, AND SANDY SILTSTONE WITH OCCASIONAL THIN BEDS OF FISSILE SHALE. BEDDING IS HORIZONTAL WITH OCCASIONAL CROSS-BEDDING AND SHALY PARTINGS. COLOR IS PREDOMINANTLY RED, BUT RANDOM GREEN BLOTCHES AND LAYERS OCCUR THROUGHOUT THE DEPTHS EXPLORED.

BORING COMPLETED ON 10-20-64
CASING TO A DEPTH OF 35'
WATER LEVEL @ 24.0' ON 11-23-64
WATER LEVEL @ 25.2' ON 1-9-65

LOG OF BORINGS

KEY TO ROCK SYMBOLS:



QUEENSTON FORMATION

QUEENSTON FORMATION WITH SHALY PHASES

QUEENSTON FORMATION WITH VERTICAL FRACTURES

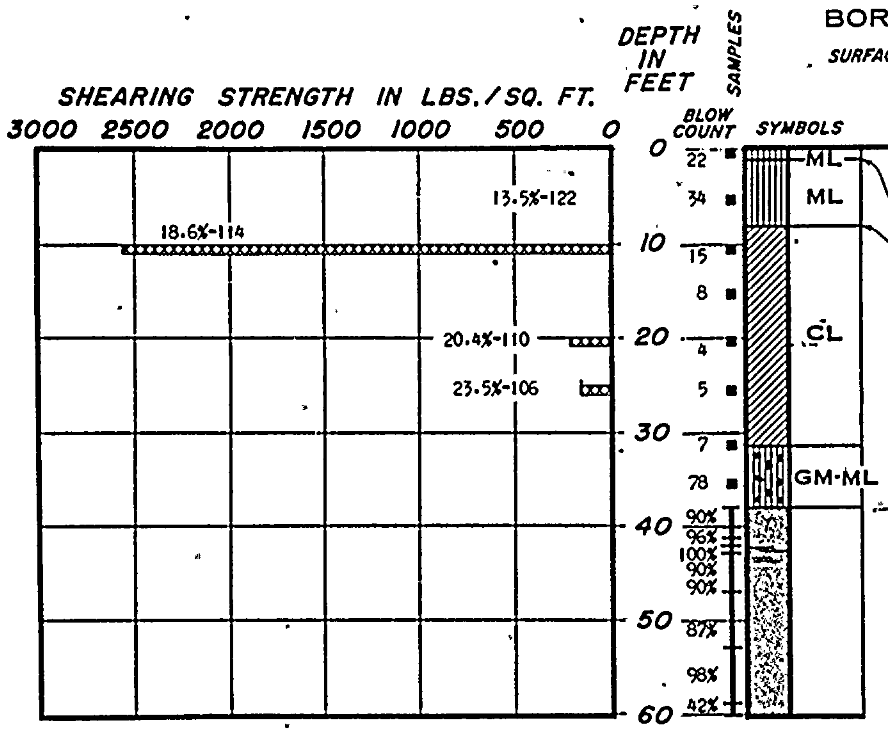
DAMES & MOORE

BY ___ DATE ___ BY ___ DATE ___ PLATE ___ OF ___

4224-001 BY ADB DATE 12-9-64 CHECKED BY HJ DATE

BORING 3

SURFACE ELEVATION +270.0'



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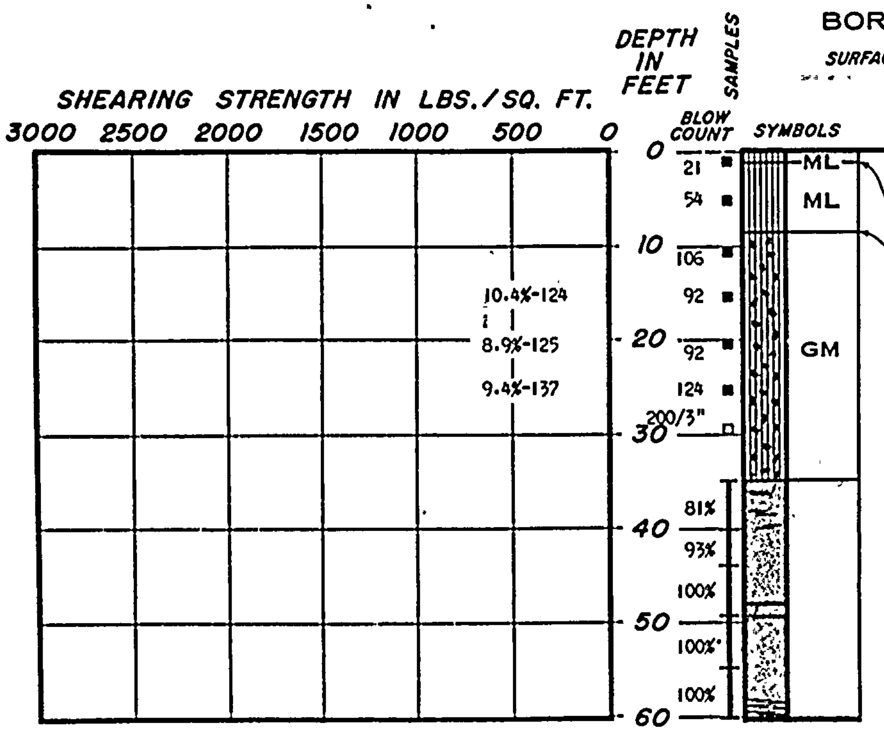
WATER LEVEL @ 25.8' ON 11-23-64
WATER LEVEL @ 25.8' ON 1-8-65

BORING 4

SURFACE ELEVATION +278.5'



DESCRIPTIONS

LIGHT REDDISH-BROWN AND GRAY SILT WITH TRACE OF FINE SAND AND ROOTS (TOPSOIL)

REDDISH-BROWN AND GRAY CLAYEY SILT WITH OCCASIONAL GRAVEL

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GRADING WITH MORE SILT

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LOG OF BORINGS

KEY TO ROCK SYMBOLS:

- QUEENSTON FORMATION
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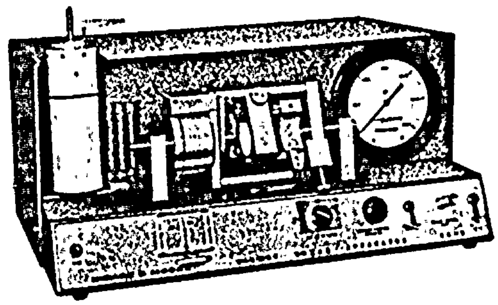
- QUEENSTON FORMATION WITH VERTICAL FRACTURES

DAMES & MOORE

PLATE IB-3c

METHOD OF PERFORMING DIRECT SHEAR AND FRICTION TESTS

DIRECT SHEAR TESTS ARE PERFORMED TO DETERMINE THE SHEARING STRENGTHS OF SOILS. FRICTION TESTS ARE PERFORMED TO DETERMINE THE FRICTIONAL RESISTANCES BETWEEN SOILS AND VARIOUS OTHER MATERIALS SUCH AS WOOD, STEEL, OR CONCRETE. THE TESTS ARE PERFORMED IN THE LABORATORY TO SIMULATE ANTICIPATED FIELD CONDITIONS.



DIRECT SHEAR TESTING
& RECORDING APPARATUS

EACH SAMPLE IS TESTED WITHIN THREE BRASS RINGS, TWO AND ONE-HALF INCHES IN DIAMETER AND ONE INCH IN LENGTH. UNDISTURBED SAMPLES OF IN-PLACE SOILS ARE TESTED IN RINGS TAKEN FROM THE SAMPLING DEVICE IN WHICH THE SAMPLES WERE OBTAINED. LOOSE SAMPLES OF SOILS TO BE USED IN CONSTRUCTING EARTH FILLS ARE COMPACTED IN RINGS TO PREDETERMINED CONDITIONS AND TESTED.

DIRECT SHEAR TESTS

A THREE-INCH LENGTH OF THE SAMPLE IS TESTED IN DIRECT DOUBLE SHEAR. A CONSTANT PRESSURE, APPROPRIATE TO THE CONDITIONS OF THE PROBLEM FOR WHICH THE TEST IS BEING PERFORMED, IS APPLIED NORMAL TO THE ENDS OF THE SAMPLE THROUGH POROUS STONES. A SHEARING FAILURE OF THE SAMPLE IS CAUSED BY MOVING THE CENTER RING IN A DIRECTION PERPENDICULAR TO THE AXIS OF THE SAMPLE. TRANSVERSE MOVEMENT OF THE OUTER RINGS IS PREVENTED.

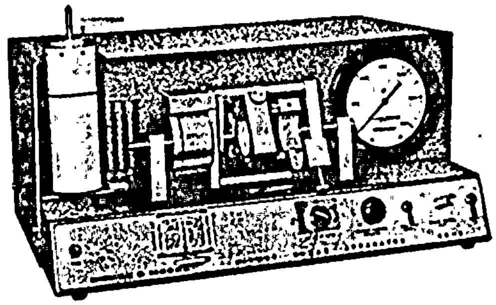
THE SHEARING FAILURE MAY BE ACCOMPLISHED BY APPLYING TO THE CENTER RING EITHER A CONSTANT RATE OF LOAD, A CONSTANT RATE OF DEFLECTION, OR INCREMENTS OF LOAD OR DEFLECTION. IN EACH CASE, THE SHEARING LOAD AND THE DEFLECTIONS IN BOTH THE AXIAL AND TRANSVERSE DIRECTIONS ARE RECORDED AND PLOTTED. THE SHEARING STRENGTH OF THE SOIL IS DETERMINED FROM THE RESULTING LOAD-DEFLECTION CURVES.

FRICTION TESTS

IN ORDER TO DETERMINE THE FRICTIONAL RESISTANCE BETWEEN SOIL AND THE SURFACES OF VARIOUS MATERIALS, THE CENTER RING OF SOIL IN THE DIRECT SHEAR TEST IS REPLACED BY A DISK OF THE MATERIAL TO BE TESTED. THE TEST IS THEN PERFORMED IN THE SAME MANNER AS THE DIRECT SHEAR TEST BY FORCING THE DISK OF MATERIAL FROM THE SOIL SURFACES.

[illegible]

Method Of Performing Direct Shear and Friction Tests



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