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=  DEEP SEA DRILLING PROJECT   =
=     VANE SHEAR DATA BASE     =
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I. INTRODUCTION

A. BACKGROUND AND METHODS

The Deep Sea Drilling Project (DSDP) vane shear data base was prepared directly from the shipboard records. Data was also taken from the Deep Sea Drilling Project Initial Reports, provided that sufficient information was given. Data which appears only on graphs within the Initial Reports was not used.

All shear strengths are encoded as grams per square centimeter. In order to convert to pounds per square inch, multiply by 0.01422 . To convert to kilopascals, divide by 10. To convert to dynes per square centimeter multiply by 980.665 .

All records have the same format. Each record is 360 characters long and represents a single shear strength measurement.

B. LEGS IN DATA SET

The database contains data from legs: 31, 38, 41, 42, 43, 44, 47, 48, 50, 51, 57, 58, 61, 63, 64, 68, 69, 71-76, 78, 80, 85, 87, 90, 91, 93, and 94. Data from legs 31, 38, 51, 58, 72, 73, 80, and 93 contain only Torvane data. Legs 57 and 87 contain both Torvane and motorized vane data. The other legs consist only of motorized vane data.

C. SELECTED REFERENCES

Boyce, R.E., 1977. Deep Sea Drilling Project procedures for shear strength measurement of clayey sediment using modified Wykeham-Farrance and laboratory vane apparatus, in: Baker, P.F., Dalziel, I.W., et al., Initial Reports DSDP, Vol. 36: Washington (U.S. Govt. Printing Office), p. 1059-1068.

Bennett, R.H., Nastav, F.L., and Bryant W.R., 1984. Strength Measurements, in: Sedimentology, Physical Properties, and Geochemistry in the Initial Reports of the Deep Sea Drilling Project, Volumes 1-44: an Overview. World Data Center A for Marine Geology and Geophysics. Report MGG-1. Chapter 8, p. 129-146.

Sibley E.A., and Yamane G., 1966 A Simple Shear Test for Saturated Cohesive Soils, in: Vane Shear and Cone Penetration Resistance Testing of In-Situ Soils. Special Technical Publication No. 399, American Society for Testing and Materials p. 39.

II. FORMAT AND FIELD DESCRIPTIONS

A. DATA FORMAT

Record length = 360 characters (4341 records)

COLUMN	FIELD	FORMAT
1-2	LEG	A2
3-5	SITE	A3
6	HOLE	A1
7-9	CORE	A3
10-11	SECTION	A2
12-15	TOP INTERVAL DEPTH (cm)(Implied decimal pt)	F4.1
16-19	BOTTOM INTERVAL DEPTH (cm)(Implied decimal)	F4.1
20-27	TOP OF CORE DEPTH (meters)	F8.2
28-35	SAMPLE DEPTH IN HOLE (meters)	F8.2
36	DATA TYPE (R=Remolded,S=Shear,T=Torvane)	A1
37-44	SPRING CONSTANT (g-cm)	F8.5
45-52	VANE CONSTANT (cm-3)	F8.5
53-54	RATE OF VANE ROTATION (degrees/minute)	I2
55-58	DEPTH OF VANE BURIAL (cm)	F4.2
59	DEFORMATION TYPE ("S","R","D","I")	A1
60	ORIENTATION ("V","H","P","N")	A1
61	TAPED (Y=Yes,N=No)	A1
62-65	TEMPERATURE	F4.1
66-68	WAIT TIME (minutes) (Remolded only)	I3
69	TORVANE (L=Low, M=Middle, H=High capacity)	A1
70	TORVANE CALIBRATION HISTORY ("B","C","D","U")	A1
	SHIPBOARD HAND CALCULATED VALUES	
71-76	SHEAR STRENGTH (g/cm2)	F6.1
77-82	REMOLDED STRENGTH (g/cm2)	F6.1
83-88	SENSITIVITY (no units)	F6.1
	DSDP COMPUTER CALCULATED VALUES	
89-94	SHEAR STRENGTH (g/cm2)	F6.1
95-100	REMOLDED STRENGTH (g/cm2)	F6.1
101-106	SENSITIVITY (no units)	F6.1
107-352	STRESS-STRAIN DATA PAIRS (41 Pairs)	82I3
353-360	OBSERVER	A8

B. FIELD DESCRIPTIONS

The definition of leg, site, hole, core and section may be found in the explanatory notes. In addition, the special core designations, as well as the methods of sample labeling and calculating absolute sample depths are discussed.

INTERVAL DEPTH:

Refers to the depth in centimeters within the section at which the top or bottom of a measurement was taken. Values are encoded with an implicit decimal point.

CORE DEPTH:
The subbottom depth in meters to the top of the core.

SAMPLE DEPTH:
The subbottom depth in meters to the middle of the sample interval.

DATA TYPE:
There are three data types.

S = Shear data:
The initial shear strength measurement done on a sample using a motorized vane apparatus.

R = Remolded data:
A repeat shear strength measurement done on a sample which already had a shear (S) type measurement done. This test is run so that the sensitivity may be calculated. Even though the remolded (R) test is conducted after the shear (S) test, the data record for the remolded test will occur before the shear test record. There is always a shear (S) test associated with each remolded (R) test.

T = Torvane data:
A single shear strength measurement obtained from one of the Torvane instruments. Unlike a motorized vane apparatus used to collect the shear (S) and remolded (R) data, the Torvane is hand held and provides a direct reading of shear strength in tons per square foot.

SPRING AND VANE CONSTANTS:
The measured constants for the springs and vanes used with the motorized vane apparatus. Calibration data for the springs and for vanes 1 to 4 can be found in Boyce(1977). Calibration data for vanes 5 to 8 are not available. Spring 5* is a torque cell used only on leg 78. The vane stem diameters are included for the sake of completeness. Although a correction may be made for the portion of the stem which is in contact with the sample, this correction has been ignored in this data base.

SPRING NUMBER	SPRING CONSTANT (g-cm)	VANE NUMBER	VANE CONSTANT (cm-3)	VANE STEM DIAMETER (cm)
1	9.1185	1	0.22858	0.32
2	20.219	2	0.22665	0.32
3	32.718	3	0.13264	0.310
4	51.106	4	0.13264	0.310
5*	35.338	5	0.2273	
		6	0.22367	
		7	0.23078	
		8	0.22115	
		9	0.2331	

RATE OF VANE ROTATION:

The rate of vane rotation was 89 degrees per minute for all the legs except leg 41 (90 deg/min) and leg 43 (60 deg/min). A rate of vane rotation is not encoded for Torvane data.

DEPTH OF VANE BURIAL:

The depth in centimeters that the vane blades were buried in the sample. Boyce's procedure calls for the vane to be buried 2.0 centimeters on unsplit cores and 1.0 centimeters on split cores. He goes on to say, "If the sample is too small to bury the blades 1.0 centimeters, then the depth of burial is measured and recorded" . This would suggest that if this data field is blank, then one may assume that the burial depth is correct for the orientation.

DEFORMATION TYPE:

Four types of deformation may be recognized by looking at the stress versus strain plot. Deformation types are defined by how the slopes (delta-stress/delta-strain) behave between adjacent data points. Only the data up to the DSDP determined (see SHEAR STRENGTH) maximum stress value are considered. Deformation types are not determined for remolded data. The deformation types are encoded as follows:

S = Smooth deformation:
The slopes start at an initial high value and then continously decrease.

R = Rough deformation:
The slopes do not continously decrease but rather increase and decrease throughout the curve.

D = Discontinous deformation:

The strain stops and starts even though the stress continued to increase steadily. This leads to a curve whose slopes repeatedly approach infinity.

I = Indeterminable deformation:
There are not enough data points present to determine the type of deformation. At least three slopes, or four stress-strain data points are required to determine the deformation type. Torvane data always has an

indeterminable deformation type.

ORIENTATION:

Boyce (1977), outlined the procedure for operating the Wykeham-Farrance motorized vane apparatus. According to this procedure, the operator was instructed to record the orientation of the vane relative to the core. How this orientation was to be noted was not specifically discussed. Boyce also discusses the orientation of the vane apparatus itself in terms of being setup either vertically or horizontally. There is no indication that this information was meant to be recorded.

Unfortunately, these ambiguities were not clarified by the work sheet used at sea. The vane shear work sheet was designed as an aid in recording the various parameters used during each shear measurement. The work sheet simply asks, "vertical or horizontal?". This certainly led to confusion as to what was vertical or horizontal; the apparatus or the core? It failed to ask for an unambiguous relative orientation between the vane and core.

Boyce does mention that the longer vanes (vane# 3 and 4) were to be used only on unsplit cores by inserting the vane in a core end. This is because these vanes could not be entirely buried in a split core. It can probably be assumed that any measurements which used either of these vanes, must have had the vane axis perpendicular to the plane of bedding. However, this assumption was not used in the development of this data base.

Marine technicians who witnessed vane shear measurements on several legs have stated that the vast majority of the measurements were done on horizontal split cores with the apparatus set up in a vertical position. This would mean that for most of the tests, the axis of the vane was oriented perpendicular to the axis of the core or parallel to the plane of the bedding.

In order to clarify the orientation when it was explicitly noted by the observer, or in a DSDP Initial Report, this field is encoded as follows:

V = Vertical (Orientation is uncertain)
H = Horizontal (Orientation is uncertain)
P = Parallel (Vane axis is parallel to bedding plane)
N = Normal (Vane axis is normal to bedding plane).

TAPED:
Was the pointer taped to the pointer deflector?
Y = Yes N = No

If untaped, the pointer would remain on the maximum stress after shearing had occurred. The pointer had to be taped to the pointer deflector if the investigator wished to measure the stress and strain readings after shearing had occurred or anytime the apparatus was operated in a horizontal position.

TEMPERATURE:
Assumed to be room temperature; which in the case of a split core would usually match the temperature of the sample.

WAIT TIME:
According to Boyce(1977) this is the time which was allowed for the vane to sit stationary in the sample before the remolded test was begun. This parameter is encoded only on the remolded (R) data records.

TORVANE:
A Torvane is a hand-held device for the rapid determination of shear strength in cohesive soils. They are manufactured by SOILTEST, INC. (2205 Lee St., Evanston, Illinois, 60202).

The device gives a direct measurement of shear strength in tons per square foot (multiply by 976.486 to get g/cm*cm). There are three interchangable vane adapters which provide different ranges of operation. Since the dial on the device does not change, it is necessary to multiply the dial reading by the maximum capacity of the adapter. The vast majority of measurements were conducted using the middle range adapter. This field is encoded as follows:

L = Low: The range is 0-0.2 tons per square foot.

M = Middle: The range is 0-1.0 tons per square foot.

H = High: The range is 0-2.5 tons per square foot.

TORVANE CALIBRATION HISTORY:

The calibration history gives information regarding the use of a calibration curve provided with the instrument. The curve compares Torvane results with values derived from unconfined and triaxial compression tests. The curve applies only to the middle range Torvane. According to the manufacturer, curves are not available for the high and low range adapters. They also warn that the shape of the curve may change depending upon the material being tested. The curve labeled "fast rate of loading" was used when calculating the DSDP shear strength. A "fast rate of loading", had a time to failure of 10-20 seconds. The points along this curve that were used by the DSDP computer program are listed

below.

The curve is a comparison of Torvane values to other shear strength methods. It is not always possible to tell whether an observer used the curve. In order to clarify when the curve was used this data field is encoded as follows:

B = Both:
The calibration curve was used by both the observer and DSDP. The observer reported the uncorrected Torvane readings. This allows the algorithm to use a digital representation of the curve to correct the readings. The digital representation is listed below. The program interpolates between the given points, and extrapolates beyond the points by using the slope between the last two points. The shipboard shear strength is checked for errors if the observer recorded the values that he obtained from the curve.

C = Caution:
The calibration curve was used only by the observer, who reported only the calibrated values. Since the raw torvane readings were not recorded, calibration was not done by the algorithm when calculating the DSDP strength. The shipboard shear strength is corrected for math errors.

D = DSDP only:
The calibration curve was used only to calculate the DSDP shear strength. It is known for certain that the observer did not use it. The shipboard shear strength is corrected for any math errors.

U = Unknown:
It is not known if the calibration curve was applied

to the original data. No corrective action is taken on the data prior to calculating the DSDP shear strength. The shipboard shear strength is corrected for math errors.

CALIBRATION CURVE USED BY DSDP COMPUTER PROGRAM

The points are given in Cartesian coordinates (x,y). The abscissa (x-axis) should be labeled TORVANE SHEAR STRENGTH (tons/ft*ft) and the ordinate (y-axis) should be labeled SHEAR STRENGTH (tons/ft*ft).

(0.0,0.00),(0.1,0.07),(0.2,0.165),(0.3,0.28),
(0.4,0.425),(0.5,0.605),(0.6,0.785),(0.7,0.965),
(0.8,1.145),(0.9,1.325),(1.0,1.505)

NOTE: A DSDP shear strength can not be calculated

without primary data. Without the Torvane reading or a calibrated value, recalculation is not possible. In this case no DSDP strength is given and the shipboard value cannot be checked for math errors.

SHEAR STRENGTH:

The shear strength (SS) or remolded strength is calculated using the following equations condensed from Boyce(1977):

SS = (vane constant)(spring constant)(maximum stress).

Two values for shear strength are encoded on each record. These are the shipboard value, calculated by the observer, and the DSDP computed value. The shipboard value is encoded directly from the observers notes taken at sea. The DSDP shear strength is calculated using a DSDP computer algorithm. The algorithm uses the stress-strain data pairs to find the maximum stress value for each trial. Since the maximum stress value chosen to calculate the shipboard shear strengths is not known, minor discrepancies between the shipboard and DSDP shear strengths are not corrected. The algorithm compares strength values and flags any gross discrepancies. Flagged values are investigated and corrected as needed.

The maximum stress, as defined within the algorithm, is the last recorded stress value before the slope of the stress versus strain curve drops below a threshold value of one. This threshold was selected as being the most applicable to the entire data set. The vast majority of data showed an abrupt decrease in slope after reaching a value of one. In addition, very few trials had slopes which ever went to zero.

The curve, as viewed by the algorithm, is made up of a series of independent slopes between adjacent data points. As a caution, the slope must drop and remain below the threshold for at least two consecutive data points. If only one stress is recorded, then this value is used as the maximum stress. If the slope of the curve never drops below one, then the greatest stress value recorded is used. On occasion, the observer failed to record the strain value associated with the final stress value. In this case, if the slopes prior to the final slope were above the threshold, then the final slope is also considered to be above the threshold, and the final stress value is used to calculate the shear strength.

The Torvane gives a direct measurement of shear strength in tons per square foot. If the Torvane reading was recorded by the observer, then a DSDP shear strength is calculated. If the Torvane reading was not recorded, recalculation is not possible and a DSDP shear strength is not given. The

DSDP shear strength, for Torvane data, is simply a recalculation of the conversion from tons per square foot to grams per square centimeter. A Torvane calibration curve is used when calculating the DSDP shear strength whenever it is appropriate (see TORVANE CALIBRATION HISTORY).

REMOLDED STRENGTH:

The remolded strength is calculated the same way as the shear strength (see SHEAR STRENGTH). The remolded strength is determined for a sample which already had a shear strength measurement done. The sample is remolded by hand and the vane is reinserted. The vane is allowed to sit stationary for about ten minutes (see WAIT TIME). The shear strength is then measured for the remolded sample. The remolded strength is used to determine the sensitivity (see SENSITIVITY). Remolded trials are not done on Torvane samples.

SENSITIVITY:

Defined as the ratio of shear strength to remolded strength.

STRESS-STRAIN DATA PAIRS:

Stress is the angle of spring rotation. Strain is the angle of vane rotation. Although not always explicitly encoded, each measurement begins with zero stress and strain.

NGDC NOTES: (list of deviations from field descriptions)

Description of deviation	Record Number(s)
Top interval depth exceeds bottom	651-652,830,1166,1278,1330
Temperature not in specified format	1361-1362,1365-1371,1595-1601, 1606-1607,1639-1640,1695-1696, 1893,2069,2683-2684,2713-2716, 2719-2720,2729,2733,2754,2760, 2777-2779,2870-2877,2880-2906, 2909-2914,2916,2919-2944,2947-2952,2957-2958,2963-2977,2979-2999,3331-3332
Stress-strain pair missing one value: cols 215-220	1945,2041

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