Annotated bibliography on vane testing in soils

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ANNOTATED BIBLIOGRAPHY ON

VANE TESTING IN SOILS

Compiled by

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INTRODUCTORY NOTE

This annotated bibliography is the result of a review of English literature on the use of the vane borer apparatus for determining the shearing strength of soils. The review was undertaken by the Soil Mechanics Section of the Division of Building Research during the early stages of a program to develop and evaluate a field vane apparatus for use in the marine clay (Leda clay) of the Ottawa and St. Lawrence River lowlands of Eastern Canada.

It is presented as a guide to the literature on this increasingly popular method of testing fine-grained soils.

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Andresen A. and L. Bjerrum. Vane Testing in Norway. Contributions to the Discussion on Symposium on Vane Shear Testing of Soils, November 1957. ASTM Special Technical Publication No. 193, 70p.

Describes the experience gathered from five years of intensive use of the vane apparatus in Norway.

Bennett, G. Bryce. "In-place" soil shearing tests with vane borer prove highly successful. Pacific Builder and Engineer, Vol. 58, No. 5, May 1952, p.66-67, 133.

The results of a field program of 290 vane tests in the bed of Lake Pend'Oreille near Sandpoint, Idaho are discussed. In general, the consolidated-quick triaxial test (samples consolidated under a cell pressure equal to the calculated effective overburden pressure) gave strength values somewhat higher than the vane test.

Bennett, G. Bryce and James G. Mecham. Use of vane borer on foundation investigation of fill. Proceedings, Highway Research Board, Vol. 32, January 1953, p.486-499.

Describes the use of a vane borer, developed by the authors, on a foundation investigation for a fill across an arm of Lake Pend'Oreille near Sandpoint, Idaho. Comparison of shearing strength records obtained by the field vane with those from unconfined compression and consolidated-quick triaxial compression tests, show a good correlation.

Cadling, L. and S. Odenstad. The vane borer, an apparatus for determining the shear strength of clay soils directly in the ground. Royal Swedish Geotechnical Institute, Proceedings No. 2, Stockholm 1950, 87p.

This is a comprehensive report of the development of the vane borer by the Royal Swedish Geotechnical Institute. It includes description of: the design, construction, and operation of the vane borer; interpretation of test results; and comparison of shear strength values obtained by this apparatus with those obtained from landslide calculations and laboratory testing. Also included in the report are the test results obtained at many sites and a discussion of the capacity and economic aspects of the vane borer.

Cadling L. and G. Lindskog. Some notes on five years experience from field vane tests in Sweden. Contributions to the Discussion on Symposium on Vane Shear Testing of Soils, November 1957. ASTM Special Technical Publication No. 193, 70p.

The Swedish soils in which vane tests are performed are soft normally consolidated or slightly over-consolidated clays (and organic clays) with high plasticity and of marine or lacustrine origin. The authors list in tabular form the suitability of field vane determined shear strengths for normally consolidated and overconsolidated clays in various construction problems.

Carlson L. Determination in-situ of the shear strength of undisturbed clay by means of a rotating auger. Proceedings, 2nd International Conference Soil Mechanics and Foundation Engineering, Vol. 1, Rotterdam 1948, p.265-70.

A report on experiments in the early stage of development of the vane tester. At shallow depths the shear strength determined by this in-situ method roughly equals the strength determined by laboratory methods. At great depths, however, the former considerably exceeds the latter. The in-situ values seem to correspond with those calculated from slides, while the laboratory values are too small.

Collins, L.E. Some foundation experiences in the Durban area. Transactions, South African Institution of Civil Engineers, Vol. 4, No. 8 and Vol. 5 No. 3. August 1954 and March 1955. Pretoria, South Africa.

The author describes the use of the Swedish vane apparatus in South Africa.

Darienzo M. and E. Vey. Consistency limits of clay by the vane method. Proceedings, Highway Research Board, Vol. 34, 1955, p.559-566.

The use of a miniature laboratory vane apparatus to measure the consistency of remoulded soils is described. Four types of clay were tested. The authors found:

1. Vane moment at the plastic limit was fairly constant for all four samples tested

2. Liquid limit as determined by the standard mechanical method corresponded to a definite vane moment for three of the clays tested

3. Shear resistance of the remoulded clays at various moisture contents computed from vane tests vary with the length of vane and bear no consistent relationship to values obtained from unconfined compression tests.

Eden, W.J. and J.J. Hamilton. The use of a field vane apparatus in sensitive clay. ASTM Special Technical Publication No. 193, Symposium on Vane Shear Testing of Soils, November 1957, p.41-53.

Reports the use of a field vane apparatus in Leda (Laurentian) clay deposits of Eastern Canada. Shear strength values obtained are compared with those found by laboratory testing of undisturbed samples. The influence of such factors as the area ratio of the vane and rod friction are discussed along with its use as a measure of sensitivity. Advantages and restrictions on the use of the field vane are also considered.

Evans, I. The measurement of the surface bearing capacity of soils in the study of earth crossing machinery. Géotechnique, Vol. 2, No. 1, June 1950, p.46-57.

The author reports the use of a field vane apparatus to give a measure of the surface bearing capacity of soils. The use of the vane in sandy loam as well as in more cohesive soils is described.

Fenske, Carl W. Deep vane tests in the Gulf of Mexico. ASTM Special Technical Publication No. 193. Symposium on Vane Shear Testing of Soils, November 1957, p.16-25.

A deep vane boring was made at a location in the Gulf of Mexico using a new vane borer. A description of the vane borer and an evaluation of its operation are given. In-place shear strength measured with the vane to a depth of 241 feet below the water surface are compared with shear strengths from laboratory tests on undisturbed samples. (Author's synopsis)

Gibbs, Harold J. An apparatus and method of vane shear testing of soils. ASTM Special Technical Publication No. 193. Symposium on Vane Shear Testing of Soils. November 1957, p.9-15.

Describes a vane apparatus developed by the U.S. Bureau of Reclamation featuring a controlled rate of testing and a simplified, accurate method of stress measurement. The author reports good agreement of the field vane determined shearing strength with that obtained by triaxial tests on undisturbed samples of saturated clays.

Grace, H. and J.K.M. Henry. The planning and design of the new Hong Kong Airport. Proceedings, Institution of Civil Engineers, Vol. 7, June 1957, p.275-305

In their description of the site investigations and design the authors outline the use of a field vane apparatus to determine the shearing strength

of foundation clays underlying a sea wall. It was found that in situ vane strengths were sometimes as much as 2 or 3 times greater than values obtained by laboratory unconsolidated undrained tests. A stability analysis of an existing satisfactorily functioning sea wall led to the belief that the field vane gave the most realistic values and final designs were based on shearing strengths equal to 80% of the field vane test value. (See also Discussion of this paper by Professor A.W. Skempton, in which he included his c/p vs. P.I. relationships.)

Gray, Hamilton. Field vane shear tests of sensitive cohesive soils. Proceedings, American Society of Civil Engineers, Vol. 81, Paper No. 755, July 1955.

A miniature laboratory vane designed to be inserted in the end of a tube sample and then rotated by means of a small torque wrench is described. The author found that in general the vane strength is substantially greater than half the compressive strength.

Hansen, J. Brinch. Vane tests in Norwegian quick-clay. Géotechnique, Vol. 2, No. 1, June 1950, p.58-63.

This report describes vane, cone, and quick shear tests on samples of Norwegian quick-clays (with sensitivities in the order of 100). A c/p ratio of 0.18 (where c denotes shear strength and p denotes effective overburden pressure) was found for this clay. Cone tests and quick shear tests both gave shear strengths which agreed reasonably well with the results of the vane tests above a depth of 15 meters, whereas below this depth they were substantially lower than vane strengths.

Hill, William C. Vane in-place soil shear device developed and applied by Oregon State Highway Department. ASTM Special Technical Publication No. 193, Symposium on Vane Shear Testing of Soils, November 1957, p.26-40.

The development and use of a field vane apparatus in determining the shearing strength of soils found in fresh water swamps and brackish water tidal flats in Western Oregon, is described. The limitations and advantages of the vane device as a field tool in locating questionable foundation areas and depths in non-granular materials and determining their shear strengths for embankment design are discussed.

Kallstenius, Torsten. Swedish vane borer design. Contributions to the Discussion on Symposium on Vane Shear Testing of Soils, November 1957. ASTM Special Technical Publication No. 193, 70p.

Includes a sketch of a vane borer apparatus used in Sweden in 1918-9

Lea, N.D. and B.D. Benedict. The "FOUNDATION" vane tester for measuring in-situ shear strength of soil. In Proceedings, 6th Canadian Soil Mechanics Conference, December 1952, National Research Council of Canada, Associate Committee on Soil and Snow Mechanics, Technical Memo. No. 27, p.60.

This report outlines the development of a gear driven, automatic stress-strain recording field vane. Results obtained with this apparatus tend to agree with shear strengths determined by consolidated-quick tests but are usually from one to three times greater than those from laboratory unconfined compression tests.

Mecham, J.G. A vane borer for testing the stability and strength of soil subgrades and soil foundations. Bulletin No. 11, Engineering Experiment Station, University of Idaho. Moscow, Idaho, December 1956, 34p.

A report of the work carried on by the Engineering Testing Laboratory and Engineering Experiment Station of the University of Idaho and the Materials Division of the Idaho Department of Highways in a study of a truck-mounted vane borer. The use of several differently shaped vanes and the effects of these shapes on soil disturbance is reported. The author concludes that the vane apparatus offers a convenient and economic method of obtaining data required in foundation designs and stability analyses.

Mohan, Dinesh and Giraraj Singh Jain. Field vane shear tests. Civil Engineering and Public Works Review. Vol. 52, No. 618, December 1957, p.1387-1388.

Reports the use of a small field vane (2 inches by 3 inches) in the black cotton soils of India. The soil tested had a shearing strength of a little over one ton per square foot and was of such a nature that fine cracks would open up with stress release brought about by sampling and trimming for laboratory testing. The authors report an indication of more reliable shear strength data by the field vane testing than by unconfined compression testing.

Murphy, V.A. Penetrometer and vane tests applied to railway earth-works. Proceedings, First Australian-New Zealand Conference on Soil Mechanics and Foundation Engineering, Melbourne, June 1952, p.135-160.

The author outlines the development and use of the field vane and penetrometer by the New Zealand Railways. Detailed drawings of both apparatus, notes on slope stability design, and the practical use of vane data, are included. (Discussion of this paper by Dr. A.W. Skempton and Mr. L.J. Murdock appear on pages 156-160 of the Proceedings.)

Newland, P.L. and B.H. Allely. Further evidence of increase of shear strength with depth provided by vane tests on a recent deposit of soft clay. Proceedings, First Australia-New Zealand Conference on Soil Mechanics and Foundation Engineering, Melbourne, June 1952, p.136-160.

The authors report investigations carried out in connection with the stability of a highway embankment founded on a 30-ft deposit of very soft, sensitive clay which would appear to have been lightly overconsolidated. Remarkably consistent results showing a linear increase in shear strength with depth were found. The paper concludes with a brief analysis of the stability of the embankments against failure by spreading.

Osterberg, J.O. Introduction to Symposium on In-Place Shear Testing of Soil by the Vane Method. ASTM Special Technical Publication, No. 193, Symposium on Vane Shear Testing of Soils, November 1957, p.1-7.

The author traces the historical development of the vane borer, briefly describes the principles and equipment used in vane testing, discusses testing techniques and factors affecting test results and finally includes the results of tests performed under his direction in Milwaukee, Wisconsin.

Skempton, A.W. Vane tests in the alluvial plain of the River Forth near Grangemouthe. Géotechnique, Vol. 1, No. 2, December 1948, p.111-124.

The use of a vane apparatus to depths of 100 ft in silty clay, is described. The author developed a technique for measuring the remoulded strength of a clay in-situ. Vane tests and unconfined compression tests were in close agreement to a depth of 45 ft. At greater depth the vane gave increasing strengths while the sample strengths remained essentially constant. The c/p ratio was found to

be 0.17 where c = undrained shearing strength and p = effective overburden pressure. Suggestions are tentatively put forward which may be helpful in deciding whether any particular set of undisturbed samples are reliable.

Skempton, A.W. and A.W. Bishop. The measurement of the shear strength of soils. Géotechnique, Vol. 2, No. 1, June 1950, p.90-108.

The authors outline the various commonly used shear strength testing techniques. The vane test is included as an undrained shearing strength testing technique.

Vey, E. and L. Schlesinger. Soil shear tests by means of rotating vanes. Proceedings, Highway Research Board, Vol. 29, 1949, p.544-53.

This paper describes tests and reports the results of vane shear tests performed in Chicago clays. The authors used an applied rate of rotation of 1 degree per minute and recorded torque versus angle of twist. From the 20 to 45 ft depth no increase in shearing strength with depth was measured. Shear strengths obtained with this method were compared with those obtained by standard lab techniques. Results indicated that vane tests are probably more reliable than unconfined compression tests. The authors discuss the possibility of a transfer of shear from an unstable skeleton structure to a constant strength clay matrix assuming the structural character of soft clay as outlined by Terzaghi.