TESTING FORUM

A Technical Report on the SPT Workshop Held During ASTM's June 1979 Committee Week

A workshop session on the standard penetration test (ASTM D 1586, Penetration Test and Split-Barrel Sampling of Soils), was held by Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations during its June 1979 meeting in Philadelphia. The purpose of the workshop was to review SPT theory and practice, and to try to formulate a basic policy for future revision of D 1586.

The shortcomings of D 1586 have been known for many years. First, it does not accurately specify the amount of energy delivered by the hammer. And second, the manner in which energy is transmitted through the drill rod to the attached sampler is not generally agreed upon, so there is no consensus on the amount of energy reaching the sampler.

With respect to the first problem, considerable work has been done by Kovaks et al [*1,2*] and others to measure and standardize the hammer velocity and kinetic energy. As a result of this work, it has become apparent that the use of the rotating sheave (cathead) and rope introduces hammer energy losses that are generally large and unpredictable.

In order to stimulate discussion on the second issue, the mechanics by which the stress wave is transmitted along the rod, a review and critique of current thinking was presented at the D18.02 workshop by the present writer. What follows is a summary of that review.

Theory

When the SPT hammer strikes the upper end of the drill rod, the kinetic energy delivered to the sampler at the bottom end of the rod is transmitted as stress wave energy down the length of the rod. Therefore, an understanding of the manner in which energy is transmitted to the sampler requires an understanding of the wave mechanics process by which energy is transmitted along the rod.

When a steel rod is struck at one end, a compression pulse travels along the rod with a velocity equal to the velocity of sound in steel. The stress associated with this wave pulse is given by the well-known equation

$$\sigma = c\rho V$$

where

σ = total stress on any given element of rod length,
c = sonic velocity,
ρ = density, and
V = velocity of element displacement relative to the rod.

Also,

$$F = \sigma A = c\rho A V \tag{1}$$

where

F = total force on element and
A = cross-sectional area of rod.

In the case where the rod is initially at rest, V represents the velocity of any given element of rod length, relative to an outside fixed coordinate system. The term V, the element velocity, should not be confused with c, the velocity of the stress wave, which has a fixed value in steel of approximately 5000 m/s (16 400 ft/s). The value V varies from zero to a maximum velocity that for SPT applications is generally less than 3.0 m/s (10 ft/s). The value of V is directly related to the velocity of the hammer on impact.

The formula $F = c\rho A V$ can be used to relate the force exerted by the hammer on the rod to the velocity of the hammer/rod interface. If the velocity V of the hammer/rod interface is known as some function of the original hammer velocity V_0 and time t, then F, the force applied to the rod as the result of the hammer impact, can be readily calculated from $F = c\rho AV$. This is equivalent to calculating a force/time curve for the stress wave.

The energy transmitted by the force/time stress wave can be calculated as follows:

$$F = \sigma A = E(\Delta l/l)A$$

where

E = modulus of elasticity,
Δl = deformation of a given element, and
l = length of the element.

Rearranging the above equation yields:

$$\Delta l = Fl/(EA)$$

since

$$l = c\Delta t$$

where Δt = time interval for the stress wave to travel the length of the element. It follows that:

$$\Delta l = Fc\Delta t/(EA)$$

If w = work done on element by force F during Δt, then:

$$w = F\Delta l = F^2 c\Delta t/(EA)$$

The value of w is equal to the energy imparted by the hammer to the rod at the rod/hammer interface during the period of time

Δt. The total energy imparted W_T is therefore equal to the summation of the values of w for each time interval, or:

$$W_T = (c/EA) \int F^2 dt \tag{2}$$

Neglecting any losses due to dispersion or attenuation, the energy in the stress wave will be the same as the energy imparted to the rod by the hammer at the interface. It is this stress wave energy in the rod which causes the sampler to penetrate the soil. However, in order to be able to use a stress wave energy value for SPT applications, it is first necessary to know the relation between sampler penetration and the soil's resisting force.

If the relation between the static force exerted on the sampler and its resulting penetration into a given soil (with specified overburden pressure) is determined, then a curve for force versus penetration can be plotted. The area under this curve is equal to the work done by the sampler in penetrating the soil. If the amount of energy delivered to the sampler is known, and if the sampler penetration is known, then the average force on the sampler can be calculated from the curve for static force versus penetration. If the simplifying assumptions are made that the sampling energy is the same in every case, and that the force/penetration curves are rectangular, then the sampler penetration force would be inversely proportional to the sampler penetration for all soils. Thus the in-situ shear strength of any soil would be directly proportional to N, the standard penetration. However, the evidence indicates that the energy associated with sampler penetration is not constant, even when the hammer's kinetic energy is kept constant. In addition, the force/penetration curves are almost certainly not rectangular, and probably cannot be represented by a simple geometrical shape such as a triangle or trapezoid.

Development of Theory

Fairhurst [3] has developed a procedure for calculating a force/time stress wave from Eq 1. His procedure is based on the following assumptions:

1. The wave pulses generated are always rectangular.
2. Stress is always uniformly distributed over both hammer and rod cross-sectional areas within a very short distance from the interface, even though the respective areas may differ considerably.
3. No wave despersion or attenuation takes place in the hammer.

For the condition where c and ρ are the same for both hammer and rod, the following equation can be derived from Eq 1, based on the fact that at the interface the force on the rod is equal to the force on the hammer:

$$V_H = (A_R/A_H)V_R \tag{3}$$

where

V_H = velocity of hammer interface, relative to far (unstrained) end of the hammer,
V_R = velocity of rod interface, relative to far (instrained) end of the rod,
A_H = cross-sectional area of the hammer, and
A_R = cross-sectional area of the rod.

Equation 3 applies to the time interval $0 < t < L_H/c$ where L_H = length of hammer. Fairhurst postulates the following model for stress wave generation: the hammer, moving at a velocity V_0, strikes the end of a stationary rod. After a short interval of time Δt, an element of rod length and an element of hammer length, each equal in length to $c\Delta t$, are compressed. The velocity of the rod element is then V_R; the velocity of the hammer element is V_H, relative to the hammer. The overall velocity of the hammer element is equal to $V_0 - V_H$, since the hammer was moving with velocity V_0 at the instant of impact. For the period of time during which a force exists between hammer and rod, they are necessarily in contact, and therefore $V_R = V_0 - V_H$. Substituting this term in Eq 3 yields:

$$V_R = V_0 - (A_R/A_H)V_R$$

which, when rearranged, yields:

$$V_R = V_0/(1 + A_R/A_H) \tag{4}$$

Equation 4 can be used to calculate V_R, which can then be substituted in Eq 1 to calculate the stress wave magnitude in the rod.

The stress wave generated at the interface travels the length of the hammer and returns to the interface at time $t = 2L_Hc$. Fairhurst postulates that during this time interval the interface force, as calculated from Eqs 1 and 4, remains constant. Therefore a rectangular stress wave is formed at the interface and travels towards both the far end of the hammer and the far end of the rod. The velocity of all the elements in each wave is the same, and is equal to V_H in the hammer and V_R in the rod (V_R and V_H should not be confused with c, which is the same for both hammer and rod and is equal to $F/[\rho A V]$.) At the instant the wave front reaches the far end of the hammer, the hammer is uniformly compressed and traveling at a velocity of $V_0 - V_H$. The wave front is then reflected from the far end of the hammer as a tension pulse that progressively releases the compressive strain in each element in turn as it travels back towards the rod/hammer interface. In order for this phenomenon to take place, the elements in the tension wave must move with a velocity of twice the original element velocity. Therefore the overall hammer velocity V_1 at the moment the reflected tension wave pulse first returns to the interface is:

$$V_1 = V_0 - 2V_H \tag{5}$$

At this point in time the hammer is again strain-free and traveling with a velocity of V_1, which can be treated as a "new" value of V_0 and substituted in Eq 4 to calculate a new value of V_R and the corresponding rod stress wave magnitude. Because V_1 is always less than V_0, this procedure will result in a calculated rod stress wave consisting of a series of stepped rectangular waves of decreasing magnitude with a period equal to $2L_H/c$. Fairhurst has developed general equations for calculating the rod stress wave; these equations predict that:

1. Energy transfer is complete for long rods, as long as $A_R/A_H \leq 1$.
2. A hammer of diameter equal to or larger than the rod diameter will not rebound upon impact.
3. When $A_R = A_H$, *all* of the hammer energy will be transferred to the rod after a time equal to $2L_H/c$, and the hammer will remain motionless without rebounding.

In the case of shorter rods, the returning tension pulse in the *rod* may return to the interface before the hammer has delivered all of its energy to the rod, thus cutting off the hammer energy. This is the basis for the common assertion that longer rods generally absorb more energy than shorter rods.

Experimental Results

The results of a series of simple rod impact experiments carried out in the Port of Los Angeles Testing Laboratory indicate that the length of the rod is a significant factor with respect to the energy delivered to the D 1586 SPT sampler. It was found experimentally that the energy delivered to a resisting medium is inversely proportional to rod length. It was also found that the hammer rebounds strongly after impact; this is contrary to the prediction of the Fairhurst theoretical model for rod impact phenomena.

The experiments were carried out with the rods supported in a horizontal position; this was done in order to eliminate the complicating factor of energy contribution resulting from the downward movement of the rod in the earth's gravitational field. When a vertical rod moves downward, its potential energy change is transferred to the resisting medium. This energy is in addition to the wave energy originally derived from the kinetic energy of the hammer at impact.

The experimental setup consisted of various lengths of ½-in. diameter cold rolled steel rod suspended horizontally in line with the hammer. Sections of 12.7-mm (½-in.) diameter rod 0.3 and 0.6 m (1 and 2 ft) long were used as hammers. In order to provide a reproducible energy-absorbing medium of suitable shear strength, a block of soft, rigid plastic foam of the type used for floral arrangements was employed. The hammer was suspended so that it would swing without rotation. In order to have it hit the rod, it was pulled aside a specified distance and then released.

It is well known that a compression wave traveling along a rod will be reflected from the far end as a tension wave, if the far end is essentially free-ended. When an additional section of rod called the "tail piece" was placed at the far end of the struck rod, it was found to have the effect of trapping the wave pulse, since the reflected tension wave could not pass the interface.

The experimental data are shown in Tables 1 and 2. These data indicate that the energy of the trapped wave pulse is essentially independent of rod length, but that the energy delivered by the rod without the tail piece is approximately inversely proportional to the length of the rod.

These data are consistent with the theory that the stress wave exists as a short wave that repeatedly travels back and forth along the rod. If the end opposite to the struck end is in contact with a resisting medium, some of this wave pulse energy will be absorbed by that medium each time the pulse is reflected from that end. It appears that during penetration the pulse normally makes repeated passes of the rod before its energy is absorbed by the resisting medium. During each pass a certain fraction of the wave energy, depending on the rod length, is also lost as a result of internal rod friction. If the pulse is trapped in a short tail piece, however, the

TABLE 1—*Experimental parameters.* [a]

Vertical displacement of hammer	64 mm
Weight of hammer	
1-ft hammer	0.303 kg
2-ft hammer	0.605 kg
Energy of hammer	
1-ft hammer	0.19 J
2-ft hammer	0.38 J
Diameter of rod, hammer and tail piece	12.7 mm (1/2 in.)
Vertical suspension distance	530 mm

[a] *1 ft = 0.305 m.*

TABLE 2—*Experimental results.*

Configuration—Length, ft[a]			Penetration, mm	Work of Penetration, J	Percent of Original Hammer Energy
Hammer	Rod	Tail Piece			
1	4	none	4.3	0.051	27
1	4	1	6.1	0.078	41
1	4	2	5.6	0.071	37
1	8	none	2.5	0.025	13
1	8	1	5.3	0.067	35
1	8	2	5.1	0.063	33
1	19	none	1.0	0.008	4
1	19	1	5.8	0.073	38
1	19	2	4.8	0.058	31
2	4	none	12.7	...	...
2	4	1	13.2	...	...
2	8	none	7.6	0.102	27
2	19	none	3.8	0.043	11

[a] 1 ft = 0.305 m.

number of wave impulses delivered to the absorbing medium in a given length of time is increased, and the distance that the pulse must travel (and consequent energy loss) between wave impulses is decreased. This is consistent with the experimental results that indicate that longer rods deliver less energy than shorter rods, but that when a tail piece of length approximately equal to the hammer length is placed at the far end of the rod, the length of the rod has very little effect on the energy delivered.

In the case of a rod placed in a vertical position and struck at the top end, the potential energy contribution resulting from the fact that the rod is displaced to a lower position must be taken into account. This potential energy is equal to the total weight of the rod multipled by its downward displacement. It is separate from, and in addition to, the kinetic energy received from the hammer. Thus a long heavy rod moving a large distance (low blow count) will receive a large potential energy contribution as compared to a short rod moving a small distance. In their classic 1957 paper, Gibbs and Holtz [*4*] noted that increasing the length of the driven rod resulted in reduced blows per foot (that is, greater penetration) in sands of medium and loose relative densities. Gibbs and Holtz concluded that the added weight of the longer rod was assisting penetration. This is consistent with the explanation that potential energy change is a contributing factor. In the case of dense and very dense sands, Gibbs and Holtz found that increasing the length of the rod did not increase penetration. Instead they found that increasing the rod length reduced penetration; they attributed this to rod flexure and whipping. Stress wave attenuation could also have been a factor.

Gibbs and Holtz concluded that the effect of rod length is relatively unimportant compared to the effect of overburden pressure, but did not provide any specific data. However, on the basis of some very simple calculations, it can readily be shown that the potential energy factor for a long rod and low blow count can be a significant percentage of the original kinetic energy of the hammer.

Energy Losses

Factors resulting in stress wave energy losses in a rod include dispersion attenuation along the rod, losses at joints (connections), and losses at the rod/hammer interface.

As reported by Palacios [*5*, p. 41] the velocity of a stress wave depends on its frequency. Shorter wave lengths have slower velocities; wave lengths less than ten times the rod radius have velocities significantly less than that of the main wave. Wave lengths around 0.45 times the rod radius travel with the minimum velocity of approximately 0.35 c. Therefore the higher frequency components will fall to the tail of the main wave as it progresses. Depending on the distribution of frequencies, this can result in considerable dispersion of the stress wave. Since energy is proportional to F^2, dispersion by itself can result in significant energy loss. Attenuation, like dispersion, is also dependent on frequency: the stress intensity is proportional to $e^{-\alpha x}$, where e is the base of natural logarithms, x is the distance traveled, and α is proportional to the stress wave frequency. Palacios [*5*, p. 56] reports an energy reduction figure of 1% in 3.0 m (10 ft) for a frequency of 4000 Hz. Using the same parameters, the figure for 30 000 Hz is approximately 7% in 3.0 m (10 ft). Fairhurst [*3*, p. 126] reports a value based on experimental data of 3% loss in 3.0 m (10 ft).

The energy loss in rod joints can be considerable. Fairhurst [*3*, p. 130] reports energy losses as high as 18.5% per joint for a single pass of the stress wave. The energy loss at the rod/hammer interface is not known. It is likely, however, that the rod/hammer area ratio and the hammer and anvil configuration are important factors. Any cushioning material that might be used would also have an effect on energy loss.

Sampler Force/Energy Relationships

It appears that the curve for static force versus penetration for the SPT sampler has never been experimentally determined for a variety of soils. The relation between static force and penetration for the SPT sampler has been estimated by Palacios [*5*, pp. 136-139] from cone penetration data, but was not confirmed by direct experiment. The relation between static force and penetration for the SPT sampler is of essential importance in order to relate the standard penetration (blow count) to the sampling energy. The SPT force/penetration relationship should be determined for different soils and overburden pressures.

Conclusions and Recommendations

The following conclusions and recommendations were made at the workshop by the present author:

1. Predictions of the energy delivered to the SPT sampler that are based on theoretical stress wave analysis are not reliable.
2. The variations in energy delivered by different types of hammers can be large and unpredictable, even when the hammer's kinetic energy at impact is constant.
3. Energy losses in the rod are large and unpredictable and increase with rod length and number and type of joints.
4. The D 1586 standard penetration test should be revised to specify hammer design and impact velocity. The anvil, rod, and rod joints should be uniquely specified. (This does not necessarily rule out the possibility of the use of more than one type of drill rod, however.)
5. A correction should be made for the potential energy contribution resulting from changes in sampler elevation during driving.
6. The STP procedure should specify a wave trap in order to minimize the effect of rod length on the measured value of N, the standard penetration.
7. The SPT sampler static force/penetration relation should be determined by direct experiments; a controlled standard penetration test, revised in accordance with the above recommendations, should be carried out on the same soils under the same conditions. This will provide a correlation between hammer energy, sampler energy, and sampler penetration force.

8. The effect of drill rod length should be evaluated by determining the standard penetration on the same specimen of soil under the same conditions, with the drill rod length being the only variable. This could conveniently be done by placing the drill rig on the upper level of a multistorey parking facility and moving the soil specimen from one level to the next.

D18.02 Committee Action

Following the technical presentation at the workshop, a general discussion was held on the need to further standardize the provisions of D 1586. It was generally agreed by the subcommittee members and visitors that the design of the hammer and anvil and the impact velocity should be standardized. Subcommittee D18.02 Chairman H. E. Davis agreed to explore the possibility of his company's fabricating and testing an SPT wave trap under full-scale field conditions.

—Frank Steiger
Vice-Chairman, Subcommittee D18.02

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[3] Fairhurst, C., "Wave Mechanics of Percussive Drilling," *Mine and Quarry Engineering*, March 1961, pp. 122-130, and April 1961, pp. 169-178 (available from Linda Hall Science Library, 5109 Cherry St., Kansas City, Mo. 6410).

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Committee D-18 News

Subcommittee Formed on Peats and Organic Soils

D.18.18 on Peats and Organic Soils, formed in November 1979 at ASTM Headquarters, is the newest addition to D-18's roster of subcommittees. The new group is charged with developing "standard classifications, test methods, practices, definitions, and specifications for peat, organic soils, and related materials." Helping to carry out that charge will be five task groups that were also formed at the November meeting. They will focus individually on the following areas: geotechnical engineering; silvicultural (forestry), agricultural, and horticultural purposes; energy and chemical purposes; sampling; and classification. Dr. Peter M. Jarrett of the Royal Military College in Kingston, Ont., was appointed chairman of the subcommittee.

The need for a new subcommittee arose when D-18 requested that it receive jurisdiction over nine peat-related standards originally developed by the now-defunct ASTM Committee D-29 on Peats, Mosses, Humus, and Related Products. When D-29 disbanded in January 1976, the documents were placed under the jurisdiction of the Society's Committee on Standards, where they remained until the new subcommittee was organized. The subcommittee's next meeting will take place in conjunction with the main committee's summer meeting during the 22-27 June Society Committee Week in Chicago. Anyone wishing further information may contact Jarrett at the Department of Civil Engineering, Royal Military College, Kingston, Ont. K7L 2W3, Canada, or Kenneth C. Pearson of the ASTM Standards Development Division, 1916 Race St., Philadelphia, Pa. 19103 (215/299-5520). Membership is open to all who are interested.

Call for Papers

Contributions are sought for a one-day symposium sponsored by Committee D-18, "Calcareous Soils in Geotechnical Engineering Practice," which will take place in January 1981. Topics of interest include the identification and classification of calcareous soils, strength and compression properties, the effects of aging and cementation on behavior, and field experiences during construction. The objective of the symposium is to assess the state of knowledge in this field with the purpose of improving ASTM standards. An ASTM special technical publication based on the symposium proceedings is anticipated.

Prospective authors should submit a one- or two-page abstract and an ASTM paper offer form by 1 July 1980 to Kenneth R. Demars, Department of Civil Engineering, University of Delaware, Newark, Del. 19711. Authors will be notified of acceptance by the end of July. ASTM paper offer forms are available from Demars or from Kathleen Greene of the ASTM Publications Division, 1916 Race St., Philadelphia, Pa. 19103 (215/299-5414).

Two D-18 Symposia Set for June

Committee D-18 will be sponsoring two symposia during ASTM's June 1980 Committee Week in Chicago. The first, "Shear Strength of Soil," will take place 25 June with Frank C. Townsend of the University of Florida and Raymond N. Yong of McGill University acting as cochairmen and panel moderators. This two-session meeting will feature state-of-the-art presentations by A. S. Saada of Case Western Reserve University and H. Y. Ko of the University of Colorado.

E. T. Selig of the University of Massachusetts will chair both sessions. The morning panelists, who will consider stress-strain and strength testing methods, will be Charles Ladd of the Massachusetts Institute of Technology, Pierre LaRochelle of Laval University in Quebec, Steven Wright of the University of Texas at Austin, and Steven Poulos of Geotechnical Engineers, Inc., in Winchester, Mass. Afternoon panelists will consider applications for analytical modeling and will include Francois Tavenas of Laval University, K. Y. Lo of the University of Western Ontario, G. Y. Baladi of the Waterways Experiment Station, and R. J. Krizek of Northwestern University.

The second symposium, slated for 23 and 24 June, is entitled "Fracture Mechanics Methods for Ceramics, Rocks, and Concrete;" this meeting is being cosponsored by D-18 and E-24 on Fracture Testing, with E-24's Steven W. Freiman of the National Bureau of Standards acting as chairman. It will include sessions on Double Torsion and Short Rod Tests—Dynamic Effects, Microstructural Effects, and Indentation Techniques. More information about either meeting may be obtained from Kenneth C. Pearson of ASTM (215/299-5520).

New D-18 Publication Released

Behavior of Deep Foundations is the title of a new publication sponsored by Committee D-18 and issued in conjunction with the D-18 symposium of the same name held in Boston in June 1978. The 609-page book, designated ASTM Special Technical Publication 670, contains 31 technical papers that were not presented at the symposium but were accepted for publication; it also includes the state-of-the art presentations on various topics that composed the symposium itself, as well as a number of discussion and closure papers. D-18 member Raymond Lundgren of Woodward-Clyde Consultants edited the volume.

In explaining the purpose of the symposium, the book's introduction notes that "with the advent of larger and better construction equipment, including high energy pile driving hammers, and with the competitive desire of industry to design pile members to their full structural capacity, there has been a move toward higher capacity pile foundations. In response to this demand," the introduction continues, suppliers of concrete, wood, and steel "have been influencing building officials to raise allowable pile stresses in codes and engineers to design for higher stresses than had customarily been used. This has forced the foundation engineer to reassess the true ultimate capacity of piles and the effects of high energy driving on the integrity of the pile member itself."

To address these concerns, the symposium included sessions entitled Design and Evaluation of Load Tests on Piles and Caissons, Soil Capacity for Supporting Deep Foundation Members, Stresses in Pile Members—Long-Term Performance and Short-Term Performance During Driving, and Design Practice—Present and Proposed—Including Considerations of Standards and Codes.

The published papers consider in addition new and innovative testing methods, data from full-scale load testing and how they are interpreted, information gained from the latest experience, advancements in soil mechanics, how foundation materials perform both during construction and under long-term loading, recent developments in knowlege of material properties, and how appropriate specifications or standards can be formulated.

The book is priced at $49.50, with a 20% discount available to ASTM members, and may be ordered from ASTM's Sales Service Department as Publication 04-670000-38. Prepaid orders should include 3% for shipping, 6% sales tax for orders from Pennsylvania or California, and 5% sales tax for orders from Maryland. Discounts are available for quantity orders. ASTM member numbers must be supplied to secure the membership discount.

Southeast Asian Soil Engineering Conference

Ths Sixth Southeast Asian Conference on Soil Engineering will take place in Taipei, Taiwan, 19-23 May 1980. The objectives of the conference are to provide an opportunity for engineers and others active in geotechnical engineering to exchange their experiences and ideas and to promote the advancement of geotechnical engineering in the region. It is sponsored by the Southeast Asian Society of Soil Engineering, the Chinese Institute of Engineering (Taiwan—Republic of China), and the Chinese Institute of Civil and Hydraulic Engineering (ROC).

The conference will be divided into sessions on soil behavior, foundations, stability and excavations, soil improvements and pavements, and engineering geology and rock mechanics. Some 60 papers will be presented.

Those wishing to attend the conference, to receive more information about it, or to obtain copies of the proceedings may write to the Secretary-General, Organizing Committee for the Sixth SEACSE, c/o Moh and Associates, 6-1, Lane 137, Yen Chi St., Taipei, Taiwan 105. Registration fees are $60 for full participants, $10 for local students, and $15 for those accompanying participants to cover admission to all official receptions. A spouses' program will be provided. Following the conference, one-, two-, and three-day tours of Taiwan have been arranged for those interested; the tours combine sightseeing and technical visits.

Subsurface Investigation Manual Planned

The National Cooperative Highway Research Program has commissioned Haley and Aldrich, Inc., consulting engineers, of Cambridge, Mass., to prepare a manual on subsurface investigations applicable to transportation; the manual will be considered for adoption as an official document by the American Association of State Highway and Transportation Officials. The new manual will supplement AASHTO's *Manual on Foundation Investigations*, which covers acquisition and use of subsurface investigation data in the design of foundations for bridges and other structures, and will extend considerations to such engineering projects as tunnels, excavations, embankments, pavements, and erosion control efforts as they relate to the development of transportation facilities. The new manual is intended for use by agency personnel responsible for the planning, design, construction, operation, and rehabilitation of transportation facilities, and should be completed by the end of 1980.

In discussing the project, Haley and Aldrich cite the virtual completion of the national highway network, worldwide energy shortages, and increasing urban population as factors contributing to "a realization that highways can no longer bear the lion's share of the burden of transporting people and goods. Other forms of mass transport must be evaluated," the firm states, "and the best of these chosen to augment, supplement, and possibly replace traditional highway links in critical areas." Changes in construction practices anticipated by Haley and Aldrich include bridges that are longer and founded on less favorable materials, the use of tunnels to save transport energy and reduce the social impact of transportation facilities, longer and higher slopes and embankments, and new construction methods and materials that will change familiar requirements for foundation investigations.

The proposed manual will identify the interrelationship between geotechnical information and specific engineering projects; provide guidance on obtaining and using subsurface investigation data; explain the practical tools and techniques available for use in subsurface investigations; provide relevant details of soil and rock classification, field testing, and laboratory testing; and discuss the orderly presentation of geotechnical information for ready use in project development.

ASTM Committee D-18 on Soil and Rock for Engineering Purposes

Scope

The promotion of knowledge, stimulation of research, and the development of specifications and methods for sampling and testing, nomenclature and definitions, and recommended practices relating to the properties and behavior of soil and rock for engineering purposes. Excluded are the uses of rock for building stone and for constituent materials in portland cement and bituminous paving and structures coming under the jurisdiction of other committees.

It will be the policy of this committee to avoid, insofar as it is possible, dealing with methods of design of engineering structures and all those features of general practice in the use of soil and rock as engineering materials which may not comprise methods of sampling and testing. It will, however, be considered within the scope of the committee's work to promote by every desirable means the close cooperation of other organizations and committees whose field of endeavor is closely allied to that of soil and rock testing.

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