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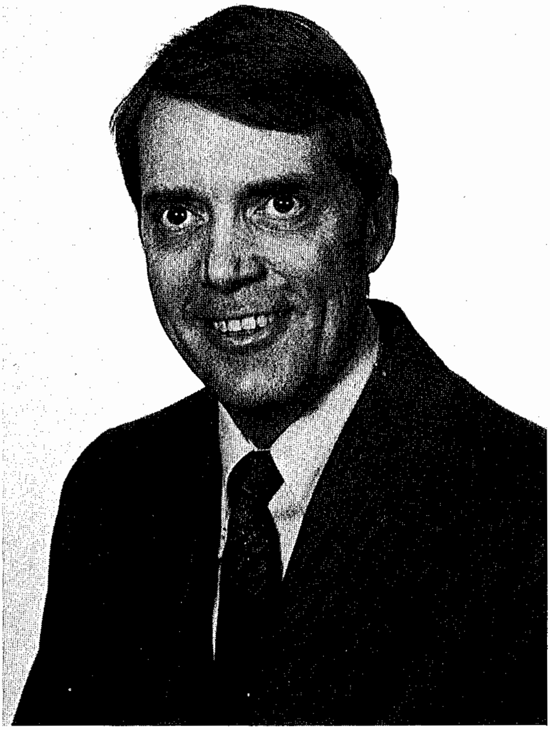


EDWARD B. KINNER
President, Boston Society of Civil Engineers Section, ASCE
1981-1982

New President's Message

I appreciate greatly the opportunity you have afforded me to serve as your president during the forthcoming year. I look forward to working with you to continue the excellent program of the B.S.C.E. Section from which we all derive benefit. In commencing my presidency, I wish to thank past President Perkins for the outstanding leadership he demonstrated during the last year. The program and achievements of his administration serve as challenges to all of us.

There are several items relating to Section activities which require attention in the months ahead. The first relates to what I will call society interaction. Some members have expressed concern that the activities of the individual technical groups do not provide for adequate interaction with other segments of the Section. To the extent considered practical and reasonable, more joint meetings of the technical groups will be held this year to foster more broadly based activities. Joint meetings with local Student Chapters will also be incorporated into the program to provide the students an opportunity to interact with the practicing engineers. Vice President Scranton will be managing the scheduling of these joint meetings. The excellent monthly luncheon series that we have had in recent years will be continued. I urge those of you in management positions to encourage attendance in the luncheon series by engineers from all levels of your organizations. Lastly, a determined effort will be made to revitalize elements of the Society's social functions. The summer clambake has been a great success recently, and this activity will be continued. However, concerted effort is needed to reverse the declining trend of the fall/winter Dance which, in fact, was not held this year. A group of "under 35" volunteers has been recruited to plan an activity which will attract both the young and the more mature.

The second general item of importance relates to Section finances. In this period of continuing inflation, the Section leadership has a responsibility for limiting expenses while continuing to provide a quality program. A thorough review of costs will be made with the intent of limiting expenses wherever possible. Our method of budgeting and accounting will also be reviewed. The Section dues have not been increased for about three years. While I prefer not to recommend a dues increase, I do consider it necessary to evaluate whether or not a dues adjustment is needed. In connection with our dues, numerous local sections have in recent years had ASCE National collect their dues. These local sections have, in general, experienced an increase in the number of dues-paying members as well as accelerated dues collection. A National dues collection program for the B.S.C.E. Section will be evaluated within the context of the unique aspects of our local structure. The final financial item relates to the investment of our Permanent Fund. The Freeman Fund Committee has raised a question concerning both the recent and current yield on investment in relation to the inflation level. As chairman of the Investment Committee, Treasurer Murdock has been asked to oversee a special re-evaluation of our investment policies. Several individuals from throughout the Section will be asked to participate in this very important effort. I ask that Mr. Murdock or I be contacted by anyone who can make a substantive contribution to this effort.

The B.S.C.E. Section Journal is another item of considerable importance. The Journal has a rich history, but in recent years has suffered a decline in availability of good technical papers. A study of the Journal by the Publications Committee last year resulted in the decision to publish two issues annually instead of four, to consider reprinting papers of significant historical interest, and to emphasize case study papers and those of practical interest. Additionally, each of the technical groups accepted the responsibility for providing at least one acceptable paper in its field annually. Vice President Rossier has been asked to ensure that these very important recommendations are implemented. I urge you all to support your Section's Journal through the submission of quality papers on both technical and professional matters.

Membership is another area which should be of great interest to us all. Our membership statistics for last year show 129 additions as compared with 99 losses. This net gain was the result of a very diligent effort by the membership committee. I have asked Vice President Rossier and Director Donnellan to take a personal interest in the membership effort this year to further promote active membership by civil engineers in Massachusetts.

The last specific topic I wish to mention pertains to our Energy Committee. An Ad Hoc Energy Committee was formed in 1979 for the purpose of stimulating local participation relative to energy issues. Commencing this year, the committee will be renamed the Energy Committee. Deletion of the Ad Hoc designation has been made to signify the rightful place of such a committee as a permanent segment of our Section's affairs. In order to provide maximum support to the Committee's efforts, I have asked that several of the technical groups co-sponsor meetings with the Energy Committee.

In closing, I wish to emphasize that the strength of the local Section depends directly on participation and support of you — the individual member. The spectrum of Section functions including the monthly luncheons, technical group meetings and lecture series, social functions and committee activities collectively provide areas for participation by engineers of all experience levels and technical or professional interests. I urge you all to actively support your Section.

Edward B. Kinner
President 1981-1982

JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS SECTION

Presidential Address

AMERICAN SOCIETY OF CIVIL ENGINEERS

ENGINEERING EDUCATION — THE NEXT TEN YEARS

Presidential Address of Frank E. Perkins[1]

Introduction

It has been the recent practice of outgoing BSCE Section Presidents to use the occasion of this message as an opportunity to summarize the past year's accomplishments and to identify future challenges facing the Section. I would like to break with that practice and return to an earlier tradition in which the President uses this message to present a technical or professional paper of general interest to the Section. To that end, I would like to share with you some thoughts that derive from my personal experience and observations in the field of engineering education. I shall title these remarks, "Engineering Education — The Next Ten Years".

My remarks are based, in large part, on a talk entitled, "Trends in Engineering Education" that I delivered recently to the Fellows of the American Consulting Engineers Council. I apologize to those who may be hearing these remarks for the second time; however, I believe that they are relevant to all members of BSCES for at least two reasons:

1. Our members are dependent on the output of the engineering educational system for their future engineer colleagues and employees; therefore, they should have an interest in what they may expect to receive from future graduates of the educational system.

2. Several current trends in engineering education imply an even larger educational role for companies, professional societies, and individual practitioners than has existed in the past. We should be preparing for this role.

[1]Presented at Part I of the Annual Meeting of the Boston Society of Civil Engineers Section, ASCE, April 21, 1981.

The Engineering Education System

The engineering education system is subjected to and responds to a variety of external and internal forces as it attempts to meet its several objectives. At any point in time, the nature of the system depends on the type of compromise that is established among these multiple forces and objectives, and the changing future of the system is driven by changes in the compromise that is reached. Thus, before describing some of the changes that may be expected in the next ten years, it is well to review some of the important objectives and forces around which a compromise system develops.

Our engineering education system has at least four major objectives:

1. *Training for Present Practice* - This is perhaps the most obvious objective and ensures that graduating engineers have some minimal level of training that permits them to be immediately useful in their initial employment.

2. *Preparation for Future Practice* - The System must ensure that its graduates are prepared for further development in the future. This is the objective that argues for an education based on underlying principles which will allow the practicing engineer to enter graduate study, participate in a program of self-education, and adapt to the changes in practice that inevitably occur during one's career.

3. *Education for Other Fields* - Significant numbers of students use their undergraduate engineering education as an entree into other professions such as law, medicine, business, etc. The presence of large numbers of such students, as occurred in the late 60's and early 70's, can drastically alter the type of engineering education that is sought.

4. *General Education* - Our engineering education system in the U.S. operates on the assumption that it is responsible for the broad liberal education of its students as well as for their technical education. In addition, the system should (although it has not always done so successfully) be responsible for the technical literacy of nonengineering students.

In attempting to strike a compromise among these somewhat conflicting objectives, the engineering education system responds to a multiplicity of forces. Among the most important sources of these are the following:

1. *Industry* - As a principal employeer of engineering graduates and a source of financial support, industry has a potentially major role to play in shaping the engineering education system. In some fields of engineering, e.g. chemical engineering, the provision of major financial support has led to an attendantly large influence on the educational system. In the field of civil engineering, such support and influence have been relatively smaller.

2. *Government* - The Federal government, through its support of sponsored research ever since World War II and more recently through its student loan and fellowship programs, has become a major force influencing the engineering education system. Government at all levels is also a major employer of civil engineers.

3. *Students* - Choices made by students, largely in response to societal pressures, are another major force acting on the system, as witnessed, for example, by the shift away from engineering in the late 60's and early 70's, and the more recent explosion of undergraduate enrollments in engineering. These, and other shifts in student interest, are translated rapidly into changes in the education system.

4. *University* - The university, in which much, but not all, of the engineering education system is based, provides its own internal forces. Principal among these are the internal reward system for faculty and students and the financial climate in which the system operates.

As noted earlier, the system changes in character with time in response to these forces. At the present time one may identify several changes which have occurred recently and are now firmly established. I would include among these the following:

1. A return to a more structured curriculum with more emphasis on fundamentals, greater concern for professional practice, and fewer individual options.

2. A reduced interest in graduate study, especially at the doctoral level, among U.S. students.

3. A growing difficulty in attracting U.S. students into the teaching profession.

4. An increase in undergraduate engineering enrollments to all-time high levels.

With these thoughts as background, let me turn to the future. Forecasts about a system as complex as the engineering education system are difficult at best and potentially very much in error if the forces identified above evolve in unexpected ways. Nevertheless, current trends and events are sufficiently clear to permit me to make a number of predictions with some reasonable expectations concerning their accuracy.

The Next Ten Years

Those changes which I expect to be particularly important over the next decade are of two general types. The first are those topical areas in the curriculum which will receive increased emphasis in response to a variety of external and internal pressures which have been growing in importance for several years and which now appear to be on the verge of finally receiving major serious attention by the engineering academic community. The second group of changes are those which result from or are part of the changing environment in which engineering education will take place in the next few years. Both types of changes — viz., areas of increased emphasis and environmental changes — are, of course, strongly related to one another.

Those areas which I expect to receive increased emphasis within the formal curriculum are three in number:

1. *Design* - During the 1960's and 1970's, greater emphasis was placed on the teaching of underlying principles and theory, frequently at the expense of current applications and design. While the reasons for these changes were defensible and the teaching of design had atrophied in many schools, it is now generally recognized that the processes and concepts that make up "design" are fundamental to engineering and must play an integral part in engineering education. New approaches based on computer-aided design have long held out the promise of a revolution in the teaching of design; that revolution now appears to be on the verge of occurring.

2. *Management* - It is widely acknowledged that a large fraction of engineers in practice devote major parts of their time and energy to activities which are broadly classed as management. In recognition of this fact, many engineering students have selected elective subjects from management school offerings, and some curricula have introduced a token subject in engineering management. Now, however, there is a growing emphasis on the establishment of formal programs of study in engineering management. These are typically offered as joint ventures between a university's engineering and management schools. I expect the development and attractiveness of such programs to increase during the next decade.

3. *Writing* - Engineering schools (and universities in general) have been severely criticized by employers in recent years for producing graduates who are inadequately prepared in the art of writing. It is generally believed that the writing problem has its roots in the secondary schools and society's reliance in television, and that the university education should somehow correct these deficiencies. It is my belief that engineering schools are at long last beginning to take this challenge seriously. In particular, it is now recognized that in order to be successful, a concern for writing must be given high priority by engineering educators, and they must take the principal responsibility for implementation. Writing programs offered in English departments may be helpful adjuncts and can be highly successful when offered jointly with engineering subjects, but real success is most dependent on the existence of engineering faculty members who are able to address the problem directly. I sense that engineering faculty will pay much greater attention to this issue in the coming decade.

I noted earlier that the environment in which engineering education takes place is also changing. In the following subparagraphs I list several of these changes that I consider to be of special importance to developments in engineering education during the next decade.

1. *Computers* - The potential role of digital computers in engineering education has been recognized for at least 20 years. Much of that potential has been transformed into reality with significant impacts on the engineering education system. However, some of the most dramatic possibilities, particularly those in the areas of interactive learning and computer-aided design, have been seriously hampered by cost and accessibility constraints. It now appears that these constraints are likely to be greatly reduced during the past few years because of continuing dramatic developments in microprocessor and computer graphics technology. Engineering students should in the near future have greatly expanded access and much improved interaction with a variety of computing devices, including those equipped with appropriate graphics and word processing capabilities. A major challenge to the education system will be to make more effective use of these facilities that has been realized to date.

2. *Continuing Education* - Students graduating today from engineering schools are choosing less frequently to enter directly into graduate study. This is occurring at a time when the increased sophistication of engineering practice is creating a demand for more advanced levels of engineering education. During his or her career, engineers are increasingly likely also to move into new areas where additional technical and managerial training is essential. Even the prospect of

relicensing engineers at various points in their career has received serious consideration. These, and other factors, point to a potentially large increase in the role of continuing education in the engineering education system. Although many successful continuing education efforts are already in existence, I anticipate that the demand for such programs will grow to the point that they constitute a major component of our engineering education system. At the same time I expect that new forms of joint efforts involving academic institutions and industry will be required if these efforts are to be maximally effective.

3. *Industry-University Interaction* - Many universities are currently heavily dependent on Federal government money for their support of students, laboratories, and research programs. That government-university relationship has been responsible for many changes in the engineering education system, many of which are viewed as positive and desirable. However, two aspects of this relationship appear to be changing simultaneously. First, many segments of industry complain that their interests and points of view are not heard by educators because of the preponderant weight of government support. The response from some industries appears at last to be a recognition that industrial support of engineering education can take many forms and is essential if the private sector point of view is to be heard. Second, the threat of large reductions in Federal support to educational institutions looms ever larger. These anticipated reductions make the importance of industry support even more crucial. I anticipate a decade ahead in which the need for and possibility of industry-university interactions is greatly increased. I personally welcome this as a desirable change in the environment.

4. *Secondary School Issues* - One of the greatest concerns to the engineering education system are recent studies of deficiencies in secondary school education in the United States. These studies seem to imply that the meeting of future demands for engineers in our technological society may be most seriously constrained by the failure of secondary schools to produce sufficient numbers of graduates adequately trained in mathematics and science. Should these forecasts prove to be correct, it is clear that the production of new engineers by our engineering education system would be constrained in terms of quantity and/or quality. The subsequent implications for U.S. industry and for possible new forms of continuing education are self-evident. I have great confidence that market forces thus generated would eventually work to rectify the situation but not without serious impacts on industry and the educational system.

Concluding Remarks

Before closing, I cannot pass up this opportunity to say a few words about the 1980-81 year for the BSCE Section. You may recall that I set five specific goals for the year. Major progress has been made toward four of these.

1. *Membership* - The Membership Committee has been aggressive in its attempts to attract new members and has met with considerable success. An important new effort to attract affiliate members was launched and has begun to produce noticeable results.

2. *Journal* - The Publications Committee reaffirmed the desirability of continuing the BSCE Section *Journal* and put forward a series of recommendations for improving the quality and financial viability of this publication. These recommendations were adopted and have already given the *Journal* a new vitality.

3. *Western Massachusetts Branch* - An effort was made to acknowledge increased enthusiasm among Western Massachusetts Branch members and to provide more tangible support for their activities. The Branch responded with an expanded program and increased participation in the Board of Government.

4. *Energy* - The ad hoc Energy Committee increased its programming efforts during the last year by cosponsoring three meetings with technical groups and one luncheon meeting. The Committee also prepared and published a draft Energy Policy Statement.

The fifth goal, that of establishing a new activity in the area of engineering management, was not successfully initiated. However, a small cadre of interested persons was identified. I remain optimistic about the prospects for future activity in this area of growing importance.

An anticipated, but unwelcome, added concern was generated by the continued impact of inflation on the Section's financial operations. The failure of investment income to keep pace with inflation and the long-term failure of the Section to add significantly to its endowment are serious problems that have not been resolved. Fortunately, the impacts of these problems have been somewhat alleviated by the magnificent efforts of our technical groups in sponsoring lecture series in recent years. In the past year the Hydraulics and Geotechnical Groups sponsored lecture series that were tremendously successful from both an educational and financial point of view.

Finally, I wish to thank the many dedicated members who have contributed in numerous ways to the successful operation of the Section during the past year. Time does not permit me to name and thank each of you personally, but please know that your efforts are important and are appreciated.

I must, however, acknowledge the special debt that I owe to our Vice-President, Dr. Edward Kinner, who shouldered such a major part of the load, and to our Executive Director, Ms. Susan Albert, who kept me on target throughout the past year.

It has been a pleasure to serve as your President. I look forward to continued participation within the BSCE Section in new roles in the future.

JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS SECTION

Professional Papers

DESIGN ESTIMATION OF THE ULTIMATE LOAD-HOLDING CAPACITY OF GROUND ANCHORS*

By G. S. LITTLEJOHN**, BSc (Eng), PhD, CEng, MICE, MIStructE, FGS

Following a brief description of the four major types of cement grout injection anchor used in current practice, empirical design methods for the estimation of the ultimate pull-out capacity of the grouted fixed anchor zone are presented.

The design rules which have been created solely through systematic full scale testing and from general field experience are discussed in relation to rocks, cohesionless soils and cohesive soils.

Topics for further investigation are highlighted such as load transfer mechanisms, grout pressure limits, fixed anchor load/displacement relationships and serviceability safety factors.

The importance of construction technique and quality of workmanship are emphasised since they influence pull-out capacity and limit the designer's ability to make accurate predictions.

Introduction

CALCULATIONS ARE ESSENTIAL in designing ground anchors in order to judge in advance the technical and economic feasibility of a proposed anchorage solution. In retaining wall tie-backs, for example, anchor dimensions can be varied in the calculations to optimise such factors as anchor load and spacing in relation to wall design and cost considerations. Design rules also permit assessment of the sensitivity of the load-holding capacity to variations in anchor dimensions and ground properties, the results of which may dictate working loads, choice of safety factors, and possibly the extent and intensity of a supplementary site investigation.

The purpose of this Paper is to describe current design procedures for cement grout injection anchors, with particular reference to estimation of the ultimate resistance to withdrawal of the grouted fixed anchor zone (Fig. 1). Bearing in mind the wide variety of theoretical and empirical equations which have been proposed to date, the text concentrates on design rules created through field experience and systematic full-scale testing.

Design rule predictions of ultimate load-holding capacity are invariably created by assuming that the ground has failed along slip lines (shear planes), postulating a failure mechanism and then examining the relevant forces in a stability analysis. Using simple practical terms there are basically two load transfer mechanisms by which ground restraint is mobilised locally as the fixed anchor is withdrawn, namely end-bearing and side shear. Anchors fail in local shear via one of these mechanisms or by a combination of both, provided that sufficient constraint is available from the surrounding ground. In this context general failure is defined as the full mobilisation of slip lines or the generation of significant deformations, extending to ground surface. Field experience indicates that general failure does not occur for slenderness ratios§ in excess of 15, and for the small diameters

* Dr. Littlejohn presented the information contained in this paper at the January 22, 1980 meeting of the Geotechnical Group of the Boston Society of Civil Engineers Section, ASCE, and previously at a symposium held by the Concrete Society of South Africa. This version of the paper is reprinted from Ground Engineering, November 1980.

**Technical Director, Colcrete Limited. Strood, Kent, England

§ Slenderness ratio = depth to top of fixed anchor/effective diameter of fixed anchor.

involved, the top of the fixed anchor is usually founded at depths in excess of 5m. In such circumstances the ultimate load-holding capacity of the anchor (T_f) is dependent on the following factors, although due to lack of knowledge item 5 is not generally isolated in design calculations:

(1) Definition of failure,
(2) Mechanism of failure,
(3) Area of failure interface,
(4) Soil properties mobilised at the failure interface, and
(5) Stress conditions acting on the failure interface at the moment of failure.

It should be emphasised that the design rules described herein for rocks and soils apply to individual anchors and no allowance is made for group effects or interference. Accordingly, it is assumed that the fixed anchor spacing is not less than four times the effective diameter (*D*), which usually means a spacing of not less than 1.5-2m. It is also noteworthy that field testing has been carried out on fixed anchor lengths (*L*) ranging from about 1 to 16m in order to create and check the design rules, but in current commercial practice a minimum fixed anchor length of 3m is considered prudent.

Anchor types

Anchor pull-out capacity for a given ground condition is dictated by anchor geometry but the transfer of stresses from the fixed anchor to the surrounding ground is also influenced by construction technique, particularly the grouting procedure, and to a lesser extent drilling technique where choice and method of

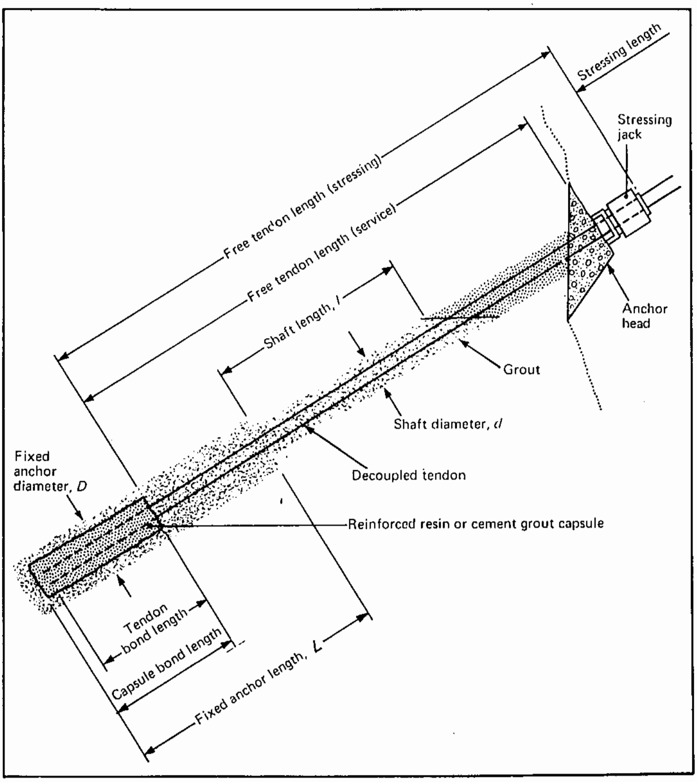


Fig. 1. Ground anchor nomenclature

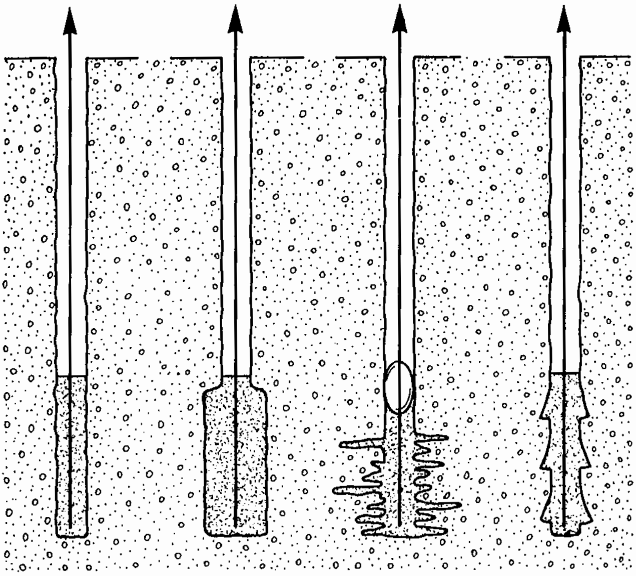


Fig. 2. Main types of cement grout injection anchor

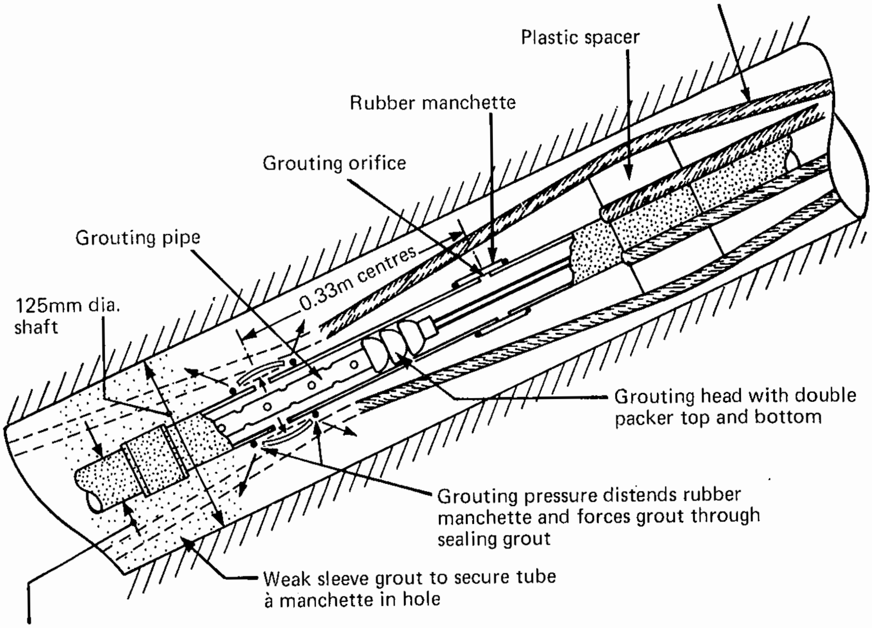


Fig. 3. Detail of tube à manchette for pressure grouting control

flush are important. Accordingly, the types of anchor to which the design rules are applicable are now described. The four types are illustrated in Fig. 2. These comprise:

Type A: Tremie-grouted straight shaft borehole, which may be lined or unlined depending on hole stability. This type is most commonly employed in rock, and very stiff to hard cohesive deposits. Resistance to withdrawal is dependent on side shear at the ground/grout interface.

Type B: Low-pressure grouted borehole via a lining tube or insitu packer, where the effective diameter of the fixed anchor is increased with minimal disturbance as the grout permeates through the pores or natural fractures of the ground. Low pressure normally implies injection at pressures not exceeding total overburden pressure. This type of anchor is most commonly employed in soft fissured rocks and coarse alluvium, but the method is also popular in fine grained cohesionless soils. Here the cement particles cannot permeate the small pores but under pressure the grout compacts the soil locally to increase the effective diameter. Resistance to withdrawal is dependent primarily on side shear in practice, but an end-bearing component may be included when calculating the pull-out capacity.

Type C: High-pressure grouted borehole via a lining tube or insitu packer, where the grouted fixed anchor is enlarged via hydrofracturing of the ground mass to give a grout root or fissure system beyond the core diameter of the borehole. Where stage grouting along the fixed anchor or regrouting are envisaged a tube-à-manchette system [1] can be incorporated as shown in Fig. 3. This anchor type is employed primarily in cohesionless soils although some success has also been achieved in stiff cohesive deposits. Design is based on the assumption of uniform shear along the fixed anchor.

Type D: Tremie-grouted borehole in which a series of enlargements (bells or under-reams) have previously been formed mechanically. This type is employed most commonly in stiff to hard cohesive deposits. Resistance to withdrawal is dependent primarily on side shear with an end-bearing component, although for single or widely spaced under-reams the ground restraint may be mobilised primarily by end-bearing.

Rock

The earliest reports of anchoring bars into rock to secure a roof date from 1918 in the Mir Mine of Upper Silesia in Poland [2], and by 1926 faces of an inclined shaft, in Chustenice shales in Czechoslovakia, were secured against caving by grouted bars installed in a fan pattern[3]. In the field of civil engineering the history of rock anchors dates from 1934 when Coyne pioneered their use during the raising of Cheurfas Dam in Algeria[4]. On this project 37 anchors were constructed in sandstone, fixed with the aid of double under-reams, and then tensioned individually to 1 000tonnes.

Whilst all anchor types *A - D* are applicable to rock, the straight shaft tremie-grouted Type *A* is the more popular in current practice on the basis of cost and simplicity of construction. For such anchors designs are based on the assumption of uniform bond distribution [5]. Thus the pull-out capacity is estimated from eqn. *1*.

$$T_f = \pi D L \, \tau_{ult} \qquad \ldots (1)$$

where τ_{ult} = ultimate bond or skin friction at rock/grout interface.

This approach is used in many countries such as France, Italy, Switzerland, Britain, Australia, Canada and USA, although it is just as common to use $\tau_{working}$, in place of τ_{ult} where a safety factor has been incorporated.

Eqn. *1* is based on the following simple assumptions:

(*i*) Transfer of the load from the fixed anchor to the rock occurs by a uniformly distributed stress acting over the whole of the perimeter of the fixed anchor,

(*ii*) The diameter of the borehole and the fixed anchor are identical,

(*iii*) Failure takes place by sliding at the rock/grout interface (smooth borehole) or by shearing adjacent to the rock/grout interface in weaker medium (rough borehole),

(*iv*) There are no discontinuities or inherent weakness planes along which failure can be induced, and

(*v*) There is no local debonding at the grout/rock interface.

Where shear strength tests are carried out on representative samples of the rock mass, the maximum average working

TABLE I. ROCK/GROUT BOND VALUES WHICH HAVE BEEN RECOMMENDED FOR DESIGN

Rock type	*Working bond (N/mm^2)*	*Ultimate bond (N/mm^2)*	*Factor of safety*	*Source*
Igneous				
Medium hard basalt		5.73	3-4	India—Rao (1964)
Weathered granite		1.50-2.50		Japan—Suzuki et al (1972)
Basalt	1.21-1.38	3.86	2.8-3.2	Britain—Wycliffe-Jones (1974)
Granite	1.38-1.55	4.83	3.1-3.5	Britain—Wycliffe-Jones (1974)
Serpentine	0.45-0.59	1.55	2.6-3.5	Britain—Wycliffe-Jones (1974)
Granite & basalt		1.72-3.10	1.5-2.5	USA—PCI (1974)
Metamorphic				
Manhattan schist	0.70	2.80	4.0	USA—White (1973)
Slate & hard shale		0.83-1.38	1.5-2.5	USA—PCI (1974)
Calcareous sediments				
Limestone	1.00	2.83	2.8	Switzerland—Losinger (1966)
Chalk—Grades I-III (N=SPT in blows/0.3m)	0.005N	0.22-1.07 0.01N	2.0 (Temporary) 3.0-4.0 (Permanent)	Britain—Littlejohn (1970)
Tertiary limestone	0.83-0.97	2.76	2.9-3.3	Britain—Wycliffe-Jones (1974)
Chalk limestone	0.86-1.00	2.76	2.8-3.2	Britain—Wycliffe-Jones (1974)
Soft limestone		1.03-1.52	1.5-2.5	USA—PCI (1974)
Dolomitic limestone		1.38-2.07	1.5-2.5	USA—PCI (1974)
Arenaceous sediments				
Hard coarse-grained sandstone	2.45		1.75	Canada—Coates (1970)
Weathered sandstone		0.69-0.85	3.0	New Zealand—Irwin (1971)
Well-cemented mudstones		0.69	2.0-2.5	New Zealand—Irwin (1971)
Bunter sandstone •	0.40		3.0	Britain—Littlejohn (1973)
Bunter sandstone (UCS>2.0N/mm^2)	0.60		3.0	Britain—Littlejohn (1973)
Hard fine sandstone	0.69-0.83	2.24	2.7-3.3	Britain—Wycliffe-Jones (1974)
Sandstone		0.83-1.73	1.5-2.5	USA—PCI (1974)
Argillaceous sediments				
Keuper marl		0.17-0.25 (0.45 c_u)	3.0	Britain—Littlejohn (1970) c_u = undrained cohesion
Weak shale		0.35		Canada—Golder Brawner (1973)
Soft sandstone & shale	0.10-0.14	0.37	2.7-3.7	Britain—Wycliffe-Jones (1974)
Soft shale		0.21-0.83	1.5-2.5	USA—PCI (1974)
General				
Competent rock (where UCS>20N/mm^2)	Uniaxial compressive strength—30 (up to a maximum value of 1.4N/mm^2)	Uniaxial compressive strength—10 up to a maximum value of (4.2N/mm^2)	3	Britain—Littlejohn (1972)
Weak rock	0.35-0.70			Australia—Koch (1972)
Medium rock	0.70-1.05			
Strong rock	1.05-1.40			
Wide variety of igneous and metamorphic rocks	1.05		2	Australia—Standard CA35 (1973)
Wide variety of rocks	0.98			France—Fargeot (1972)
	0.50			Switzerland—Walther (1959)
	0.70			Switzerland—Comte (1965)
		1.20-2.50		Switzerland—Comte (1971)
	0.70		2-2.5 (Temporary) 3 (Permanent)	Italy—Mascardi (1973)
	0.69	2.76	4	Canada—Golder Brawner (1973)
	1.4	4.2	3	USA—White (1973)
		15-20 per cent of grout crushing strength	3	Australia—Longworth (1971)
Concrete		1.38-2.76	1.5-2.5	USA—PCI (1974)

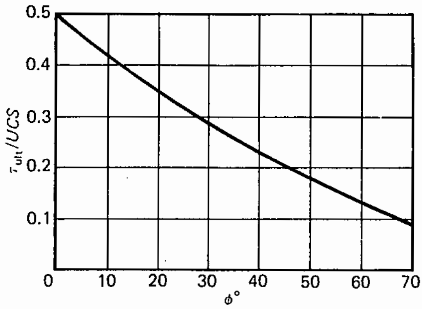


Fig. 4. Effect of ϕ on τ_{ult}/UCS ratio

bond stress at the rock/grout interface should not exceed the minimum shear strength divided by the relevant safety factor (normally not less than 2). This approach applies primarily to soft rocks where the uniaxial compressive strength (UCS) is less than 7N/mm², and in which the holes have been drilled using a rotary-percussive technique. In the absence of shear strength data or field pull-out tests the ultimate bond stress is often taken as one-tenth of the uniaxial compressive strength of massive rocks (100 per cent core recovery) up to a maximum value τ_{ult} of 4.2N/mm². As confirmation τ_{ult} = 4.3N/mm² is indicated for design in hard coarse grained sandstone by Canadian research [6].

In some rocks, particularly granular weathered varieties with a relatively low ϕ value, the assumption that τ_{ult} equals 10% UCS may lead to an artificially low estimate of shear strength (Fig. 4). In such cases, the assumption that τ_{ult} equals 20-35% UCS may be justified.

Bond values which have been recommended [5] for a wide range of igneous, metamorphic and sedimentary rocks, are presented in Table I. Where included, the factor of safety relates to the ultimate and working bond values, calculated assuming uniform bond distribution. It is common to find that the magnitude of bond is simply assessed by experienced engineers and the value adopted for working bond stress often lies in the range 0.35 – 1.4N/mm².

The Australian Code [7] states that whilst a value of 1.05N/mm² has been used in a wide range of igneous and sedimentary rocks, site testing has permitted bond values of up to 2.1N/mm² to be employed.

TABLE II. FIXED ANCHOR LENGTHS FOR CEMENT GROUTED ROCK ANCHORS WHICH HAVE BEEN EMPLOYED OR RECOMMENDED IN PRACTICE

Fixed anchor length (metres)		*Source*
Minimum	*Range*	
3.0		Sweden—Nordin (1966)
3.0		Italy—Berardi (1967)
	4.0- 6.5	Canada—Hanna & Seaton (1967)
3.0	3.0-10.0	Britain—Littlejohn (1972)
	3.0-10.0	France—Fenoux et al (1972)
	3.0- 8.0	Italy—Conti (1972)
4.0 (very hard rock)		South Africa—Code of Practice (1972)
6.0 (soft rock)		South Africa—Code of Practice (1972)
5.0		France—Bureau Securitas (1972)
5.0		USA—White (1973)
3.0	3.0- 6 0	Germany—Stocker (1973)
3.0		Italy—Mascardi (1973)
3.0		Britain—Universal Anchorage Co. Ltd. (1972)
3.0		Britain—Ground Anchors Ltd. (1974)
3.5 (chalk)		Britain—Associated Tunnelling Co. Ltd. (1973)

In this connection the draft Czech Standard[8] concludes that since the estimation of bond magnitude and distribution is a complex problem, field anchor tests should always be conducted to confirm bond values in design, as there is no efficient or reliable alternative. Certainly, a common procedure amongst anchor designers is to arrive at estimates of permissible working bond values by factoring the value of the average ultimate bond calculated from test anchors.

In general, there is a scarcity of empirical design rules for the various categories of rocks, and as shown in Table I too often bond values are quoted without provision of strength data, or a proper classification of the rock and cement grout.

The degree of weathering of the rock is a major factor which affects not only the ultimate bond but also the load-deflection characteristics. Degree of weathering is seldom quantified but for design in soft or weathered rocks there are signs that the standard penetration test is being further exploited. For example, in weathered granite in Japan the magnitude of the ultimate bond has been determined[9] from eqn. *2*.

$$\tau_{ult} = 0.007N + 0.12 \text{ (N/mm}^2) \quad \dots (2)$$

where N = number of blows per 0.3m

Similarly, eqn. *3* has been established for stiff/hard chalk[10]

$$\tau_{ult} = 0.01N \text{ (N/mm}^2) \quad \dots (3)$$

Fixed anchor length

The recommendations made by various engineers with respect to length of fixed anchor[5] are presented in Table II. Under certain conditions it is recognised that much shorter lengths would suffice, even after the application of a generous factor of safety. However, for a very short anchor the effect of any sudden drop in rock quality along the fixed anchor zone, and/or constructional errors or inefficiencies could induce a serious decrease in that anchor's capacity. As a result a minimum length of 3m is often specified.

In Italy, much valuable experimental research[11] has been conducted into the distribution of stresses both along the fixed anchor and into the rock. From this work it is concluded that the active portion of the anchor is independent of the total fixed anchor length, but dependent on its diameter and the mechanical properties of the surrounding rock, especially its modulus of elasticity.

Fig. 5 shows typical diagrams[11] which illustrate the uneven bond distribution as calculated from strain gauge data. Both anchors were installed in 120mm diameter boreholes in marly limestone ($E = 3 \times 10^4$kN/m²; UCS = 100N/mm² approx.). Other results show that the bond distri-

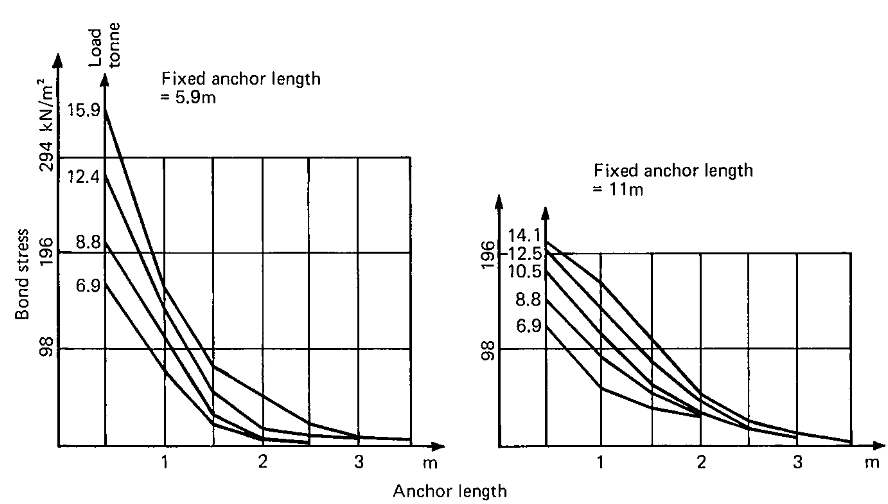


Fig. 5. Distribution of bond along fixed anchor length

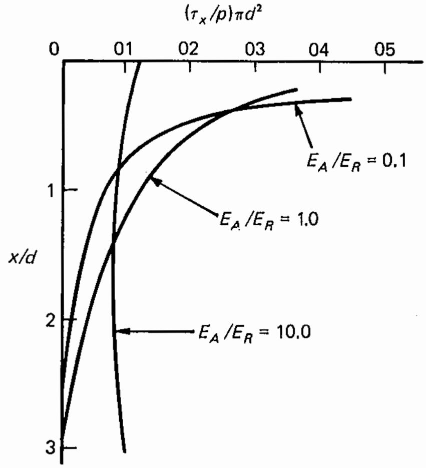


Fig. 6. Variation of shear stress with depth along the rock/grout interface of an anchor ($E_A \equiv E_{grout}$)

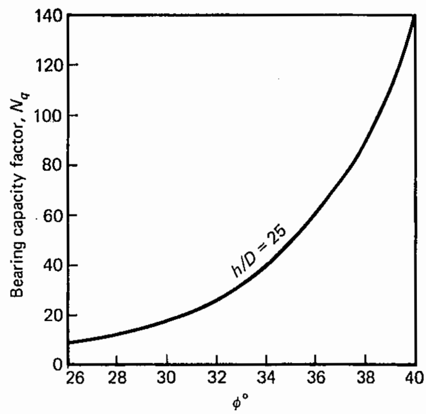


Fig. 7. Relationship between bearing capacity factor N_q and angle of internal friction ϕ

butions are more uniform for high values of E_{grout}/E_{rock}, non-uniform for low values of this ratio, i.e. for rock of high elastic modulus. These findings have also been predicted by Canadian researchers [12] (Fig. 6).

Remarks

It may be concluded that the distribution of the bond mobilised at the rock/grout interface is unlikely to be uniform unless the rock is "soft". It appears that non-uniformity applies to most rocks where E_{grout}/E_{rock} is less than 10.

It is realised that the determination of the modulus of elasticity is rather involved and expensive, particularly for rock masses. However, as the influence of this parameter on anchor performance has already been demonstrated, efforts should be made whenever possible to obtain a realistic value in order to advance our understanding.

Although it would appear from evidence presented that the assumptions made in relation to uniform bond distribution are not strictly accurate, it is noteworthy that few failures are encountered at the rock/grout interface and new designs are often based on the successful completion of former projects; that is, former "working" bond values are re-employed or slightly modified depending on the judgement of the designer.

Cohesionless soils

It was in Germany in 1958 that Bauer [13] for the first time demonstrated that a bar could be anchored into gravels through a 150mm diameter borehole with the aid of cement grout injection under pressure. Since then the development of grouted anchors in frictional soils has steadily gained momentum, particularly in Europe, the Americas and South Africa.

For low pressure grouted anchors of Type *B* the ultimate load holding capacity T_f is most simply estimated from eqn. *4*.

$$T_f = L\,n \tan\phi \qquad \ldots (4)$$

where L = fixed anchor length (m)
ϕ = angle for internal friction
n = factor which apparently takes account of the drilling technique (rotary-percussive with water flush), depth of overburden and fixed anchor diameter, grouting pressure in the range 30 - 1 000kN/m², insitu stress field and dilation characteristics.

Field experience[10] indicates that for coarse sands and gravels ($k_w > 10^{-4}$m/sec), n ranges from 400 – 600kN/m, whilst in fine to medium sands ($k_w = 10^{-4}$ to 10^{-6}m/sec) n reduces to 130-165kN/m.

Eqn. *4* is simple but crude and is used mainly by specialist contractors familiar with their own particular anchorage system. The rule tends to be conservative in view of the limited use of information concerning anchor dimensions and ground parameters, and the underestimate can be significant if the rule is applied to dense "over-consolidated" alluvium where the n values were initially established in "normally consolidated" materials. In this regard the over-consolidation ratio (OCR) should be quantified in ground investigation reports, to permit more field studies into the effect of OCR and relative density on pull-out capacity. For more general use eqn. 5 is recommended since it relates anchor pull-out capacity to anchor dimensions and soil properties[10].

$$T_f = A\,\sigma'_v\,\pi DL\tan\phi + B\,\gamma\,h\frac{\pi}{4}(D^2 - d^2)$$

(side-shear) + (end-bearing) ... (5)

where

A = ratio of contact pressure at the fixed anchor/soil interface to the average effective overburden pressure,
γ = unit weight of soil overburden (submerged unit weight beneath the water table),
h = depth of overburden to top of fixed anchor,
L = length of fixed anchor,
σ'_v = average effective overburden pressure adjacent to the fixed anchor (equivalent to $\gamma\,(h+L/2)$ for a vertical anchor in ref. 10),
D = effective diameter of fixed anchor,
ϕ = angle of internal friction,
B = bearing capacity factor, and
d = effective diameter of grout shaft above fixed anchor.

In practice the fixed anchor diameter (D) is rarely assessable with any accuracy, but approximate estimates can be made from grout takes in conjunction with ground porosity. For boreholes of 100 to 150mm, D values of 400 - 500mm can be attained in coarse sands and gravels, say 3 - 4d. Where grout permeation is not possible and only local compaction is achieved, D values for the above borehole diameters and an applied pressure up to 1 000kN/m^2, may range from 200 - 250mm for medium dense sand[10], say 1.5 - 2d. For very dense sand D values of 180 - 200mm have been attained[14], say 1.2 - 1.5d.

The value of B depends on the angle of shearing resistance of the soil adjacent to the top of the fixed anchor, and slenderness ratio (h/D). Based on Russian research[15], the relationship between the conventional bearing capacity factor (N_q) and ϕ is shown in Fig. 7 for slender piles. Up to a value of 15, h/D can influence N_q significantly, but for increasing slenderness ratios the effect becomes progressively less significant (Table III). A complimentary study[16] has also indicated that N_q/B equals 1.3-1.4, and this combined information is used in current practice to estimate B. For compact sandy gravel ($\phi = 40°$) at Vauxhall Bridge, London, and compact dune sand ($\phi=35°$) at Ardeer, Scotland, values of B equal to 101 and 31 have been measured in the field[10], which are in good agreement with respective values of (99-106) and (35-38) estimated via Fig. 7.

The value of A depends to a large extent on construction technique and for the Type B anchor relevant to eqn. 4, values of 1.7 and 1.4 have been recorded in compact sandy gravel ($\phi = 40°$) and compact dune sand ($\phi = 35°$) respectively[10].

The end-bearing component of eqn. 5 is occasionally omitted by anchor specialists, perhaps on the basis that anchor yield can be recognised at relatively small fixed anchor displacements, which do not permit full mobilisation of the end-bearing resistance. In this regard eqn. 6 has been produced in British Columbia[17] for grouted bar anchors installed in medium to dense sandy gravel with some cobbles ($\phi =$ 35°-42°)

$$T_f = K_1\,\pi DL\,\sigma'_v\tan\phi \qquad \text{... (6)}$$

where K_1, coefficient of earth pressure, varies from 1.4 to 2.3 with no grout injection pressure.

For fine sands and silts recommended values for K_1 are 1.0 and 0.5 for high and low relative densities, respectively[18], although it is recognised that K_1 is probably dependent on injection pressure[19]. For dense sands in Boston, Massachusetts[20], K_1 = 1.4 has been obtained for the Bauer anchor. Bearing in mind the difficulty in assessing the effective fixed anchor diameter (D), eqn. 7 using the shaft or borehole diameter (d) has been sug-

TABLE III. APPROXIMATE RELATIONSHIP BETWEEN N_q AND SLENDERNESS RATIO

h/D	φ 26°	30°	34°	37°	40°
15	11	20	43	75	143
20	9	19	41	74	140
25	8	18	40	73	139

gested for design in Sweden[21].

$$T_f = K_2 \pi dL \sigma'_v \tan \phi \qquad \ldots (7)$$

Based on tests in coarse silt and fine sand at Sundsvall, and sand and gravel at Uppsala, K_2 ranges from 4 to 9 with an average value of 6 for injection pressures of 300-600kN/m².

In 1970 it was estimated[10] for eqn. *5* that *A* lay in the range of 1-2, but that if the soil was not compacted or displaced during the casing installation and no residual grout pressure was left at the fixed anchor grout/soil interface on completion of the injection stage, *A* might reduce to a value approximating to K_o. In the light of experience this reduction is now considered unduly pessimistic since even with tremie grouting the full hydrostatic head of the grout is applied at the fixed anchor interface, which creates a contact pressure greater than $K_o \sigma'_v$ in normally consolidated ground.

As a consequence, even for the tremie grouting method it is difficult to envisage a value of *A* less than 1 for design purposes. In fine grained materials *A* depends greatly on the residual grout pressure at the fixed anchor/soil interface which is some function of the injection pressure since during injection the cement forms a filter cake at the interface through which only water travels. Thus, the injection pressure is transmitted to the soil, and when the grouting is complete there is sufficient shear strength in the grout placed coupled with ground restraint to enable a residual pressure to be locked into the system. In such circumstances eqn. *8* has been used by some contractors, particularly in Continental Europe.

$$T_f = P_i \pi DL \tan \phi \qquad \ldots (8)$$

where P_i = grout injection pressure.

This rule has been tested recently for injection pressures of 1 000-2 000kN/m² in dense fine uniform sand ($\phi = 40°$) at Küçük Cekmece Lake in Turkey[22]. In such soil the rule is shown to overestimate pull-out capacity and a modified version (eqn. *9*) is recommended.

$$T_f = 2/3\ P_i \pi DL \tan \phi \qquad \ldots (9)$$

The overestimate of eqn. *8* has been further highlighted for the very dense shelly sand at Orford Ness, England[14] and injection pressures of 1 000 to 1 400 kN/m², where the residual pressure approximated to 1/3 P_i. It is considered that as the in situ permeability of the soil increases, filter cake formation becomes more difficult and hence more of the injection pressure is dissipated during the plastic stiffening stage, as the grout slowly permeates through the soil. In this regard the stiffening time and shrinkage of the grout, together with the load/deformation properties of the soil may also be influential. In spite of this apparent restriction design curves, based on the work of Jorge[23], have been published relating grouting pressure directly to ultimate load capacity per metre of fixed anchor for major classes of ground[24] (Fig. 8). These curves are used primarily for Type *C* anchors where the injection pressures usually exceed 1 000kN/m².

It is a feature of Type *C* anchors that calculations are based on design curves created from field experience in a range of soils rather than relying on a theoretical or empirical equation using the mechanical properties of a particular soil. In alluvium for example, test results[23] in medium sand in Brussels, alluvium at Marcoule, sands and gravels at St-Jean-de-Luz, and Seine alluvium at Bercy have indicated for 100-150mm diameter boreholes ultimate load-holding capacities of 90-130kN/m of fixed anchor at P_i of 1 000kN/m², and 190-240kN/m at P_i of 2 500kN/m².

In more recent years design curves for Type *C* anchors have been extended through basic tests in Germany[25, 26], and for sandy gravels and gravelly sands Fig. 9 shows[26] how the ultimate load increases with density and coefficient of uniformity. Compared with these two soil properties, increases in grouting pressure over the range 500-5 000kN/m², and fixed anchor diameter (100-150mm) are found

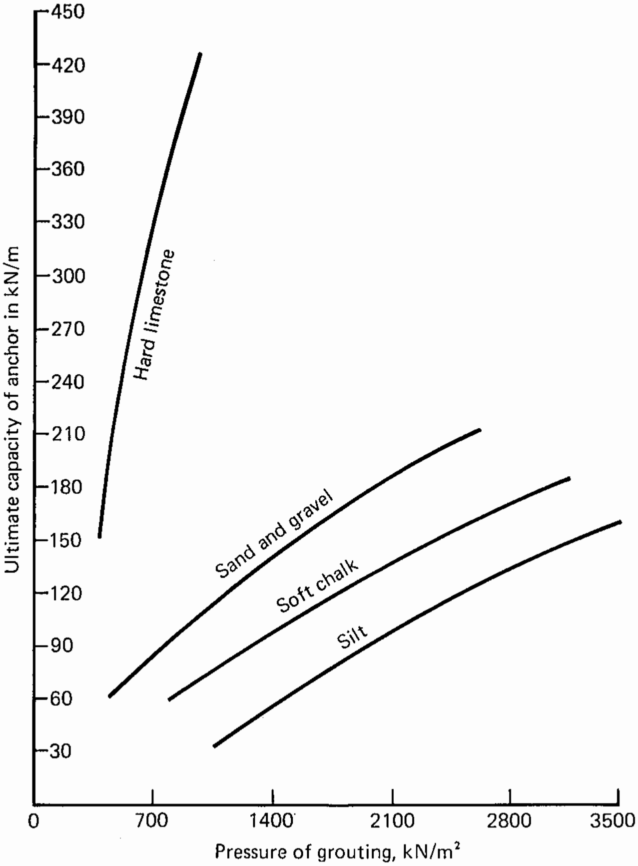


Fig. 8. Influence of grouting pressure on ultimate load-holding capacity

to have little influence on pull-out capacity which contrasts with the French observations[23]. In this regard the particular use of the tube-à-manchette system in the French tests to provide a secondary stage of grouting at high pressure may explain the different emphasis on injection pressure.

For the German design curves average skin frictions can be as high as 500kN/m² for sand, and 1 000kN/m² for sandy gravel. Since these skin frictions are much higher than would normally be predicted by conventional soil mechanics theory, the values attained in ground anchors are explained by an interlocking or wedging effect due to dilation of the soil as the fixed anchor is withdrawn. The effect is an increase in radial or normal stress at the ground/grout interface, and values of 2-10 times the effective overburden pressure have been noted. For very dense fine to coarse gravelly sand at National Capital Bank in Washington DC[27], (P_i = 2 800-3 100kN/m²), radial stresses of approximately 20 × the overburden pressure have been deduced.

In practice density is commonly measured indirectly by in situ penetrometer tests, and Fig. 10 illustrates how penetration resistance can be used to provide a rough estimation of ultimate load holding capacity for 3m 6m and 9m fixed anchor lengths[26]. The authors emphasise,

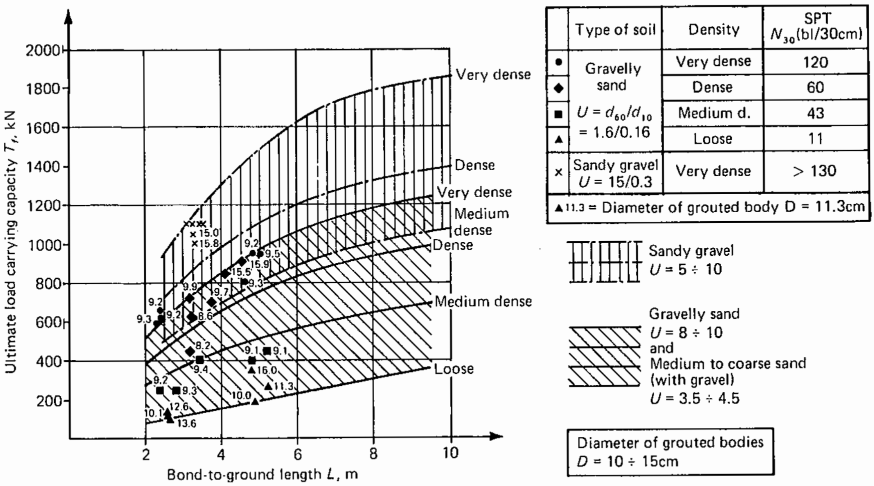


Fig. 9. Ultimate load-holding capacity of anchors in sandy gravel and gravelly sand showing influence of soil type, density and fixed anchor length

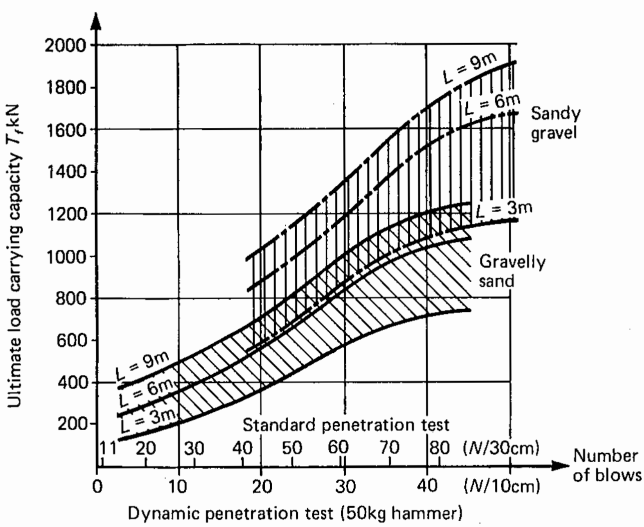


Fig. 10. Relationship between ultimate load-holding capacity, fixed anchor length and dynamic penetration resistance for two types of frictional soil

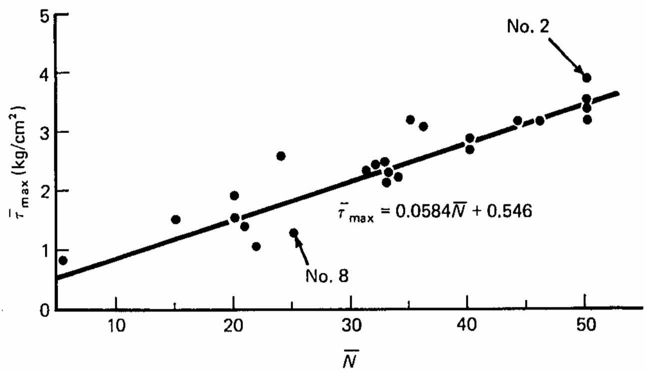


Fig. 11. Relationship between maximum skin friction and mean N value ($\bar{N}$)

however, that certain fluctuations in test results are possible due to the soil inhomogeneity even when anchors have been properly installed. Japanese investigators[28] have also provided a relationship between maximum skin friction and mean *N* value (Fig. 11).

The most sophisticated attempt to calculate accurately load-holding capacity is provided by an evaluation of test anchors in Hannover, West Germany[29] using statistical methods, specifically a linear multiple regression analysis. For frictional soils eqn. *10* is recommended:

$$T_f = a_0 + a_1 \pi DL + a_2.D_5 + a_3.D_6 + a_4.D_7 + a_5.D_8 + a_6.k + a_7\tau \quad \ldots (10)$$

where $\tau = \dfrac{2 - \sin\phi'}{2} \gamma\, h_m \,.\, \tan\phi'$ (kN/m²)

aj = regression constants,
D = effective fixed anchor diameter (cm),
L = fixed anchor length (m),
D_5 = % soil grains with diameters < 0.2mm,
D_6 = % soil grains 0.2mm $<$ dia. $<$ 0.6mm,
D_7 = % soil grains 0.6mm $<$ dia. $<$ 2.0mm,
D_8 = % soil grains dia. $>$ 2.0mm,
k = coefficient of permeability (cm/sec),
γ = unit weight (kN/m³), and
h_m = depth of overburden to mid-point of fixed anchor (m)

The correlation analysis yielded a multiple correlation coefficient of 0.96 and the following values for the constants of eqn. *10:*

$a_0 = -2679.36$		$a_4 = +\ 20.63$	
$a_1 = +\ 34.12$		$a_5 = +\ 31.92$	
$a_2 = +\ 29.20$		$a_6 = -2051.48$	
$a_3 = +\ 30.94$		$a_7 = +\ 9.73$	

Even with this mathematical sophistication however, there is no possibility of taking into account different construction procedures, and this rule applies solely to anchors of Type *C*.

Using eqn. *10* to estimate the pull-out capacity it must be observed that the grain size curve lies within the boundaries of Fig. 12 and that the values of the influence factors do not exceed the following limits:

$0.98\text{m}^2 \leqslant \pi DL \leqslant 3.61\text{m}^2$
$7.40\text{cm} \leqslant D \leqslant 11.50\text{cm}$
$4.10\text{m} \leqslant L \leqslant 15.00\text{m}$
$0\% \leqslant D_5 \leqslant 86\%$
$10\% \leqslant D_6 \leqslant 78\%$

$0\% \leqslant D_7 \leqslant 17\%$
$0\% \leqslant D_8 \leqslant 77\%$
$0.122\ 10^{-2}\text{cm/s} \leqslant k \leqslant 25.2\ 10^{-2}\text{cm/s}$
$31.7\text{kN/m}^2 \leqslant \tau \leqslant 95.6\text{kN/m}^2$

The importance of these limits and boundaries cannot be overemphasised as field experience[30] indicates that use of one parameter outside the stipulated range e.g. *k* which may then be incompatible with the grain size, can produce

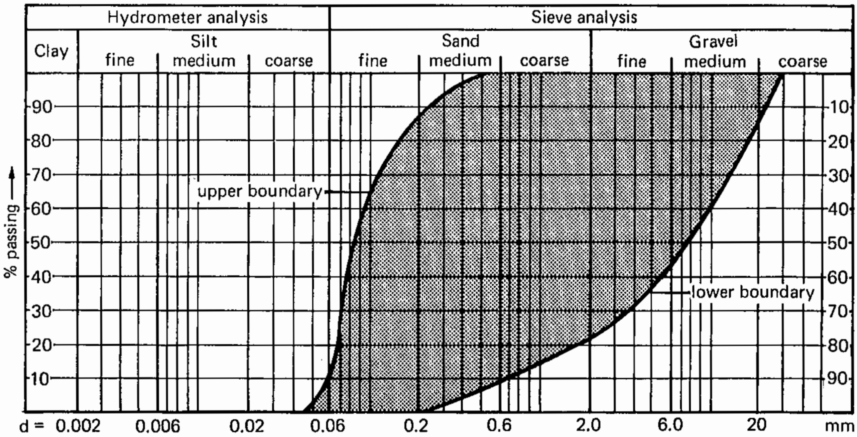


Fig. 12. Boundaries of the grain size distribution of the investigated frictional soil

anomalous results.

Distribution of skin friction

Designs are normally based on the assumption of an equivalent uniform skin friction; actual field values[20, 26] are rare and even then are estimated from bond stresses at the grout/tendon interface. For the last loading step before failure is reached Fig. 13 shows for instrumented anchors the distribution of skin friction on fixed anchors ranging from 2 to 4.5m in length[26].

The decisive influence of soil density is clearly shown by the maximum τ_s values of 150, 300 and 800kN/m² for loose, medium dense and very dense gravelly sand, respectively. For the 4.5m long anchors in loose and medium dense gravelly sand, skin friction is more or less constant over the ground/grout interface. For dense and very dense sands the maximum values are effective along a relatively short length, and the location of this peak zone shifts distally as the test load increases. These observations for Type *C* anchors have been confirmed in similar very dense frictional soils in Washington DC[27], where it was also noted that fixed anchor displacements of only 2-3mm were required to mobilise high values of load transfer (150-370kN/m).

Assuming that the limit value or maximum τ_s is identical for different fixed anchor lengths, the mean values of τ_s for long anchors are smaller than for short anchors, a feature which is apparent in Fig. 9. Taken to the extreme there exists a critical limit to the effective fixed anchor length beyond which there is no evident increase in load-holding capacity. Fig. 14 for dense frictional soil (N=50) indicates[28] very small load increases for L greater than 6.7m, which supports Ostermayer[25] who concluded that 6-7m was optional from an economic point of view.

Remarks

For pressure-grouted anchors of Type *B* and *C*, two distinct design approaches have evolved — namely empirical equations and design envelopes, respectively. Since the main distinction between the two anchor types relates to the magnitude of grout injection pressure, more guidance is required on injection pressure limits which would determine if the ground is to be permeated or hydrofractured.

Cohesive soils

For tremie-grouted straight shaft anchors of Type *A*, the pull-out capacity is most conveniently estimated from eqn. *11*.

$$T_f = \pi D L \alpha c_u \qquad \ldots (11)$$

where c_u = average undrained shear strength over the fixed anchor length, and

α = adhesion factor.

In stiff London Clay (c_u>90kN/m²) α values of 0.3-0.35 are common[31], bearing in mind the dilute cement grout (w/c ⩽0.40) usually employed. Type *A* anchors installed in stiff overconsolidated

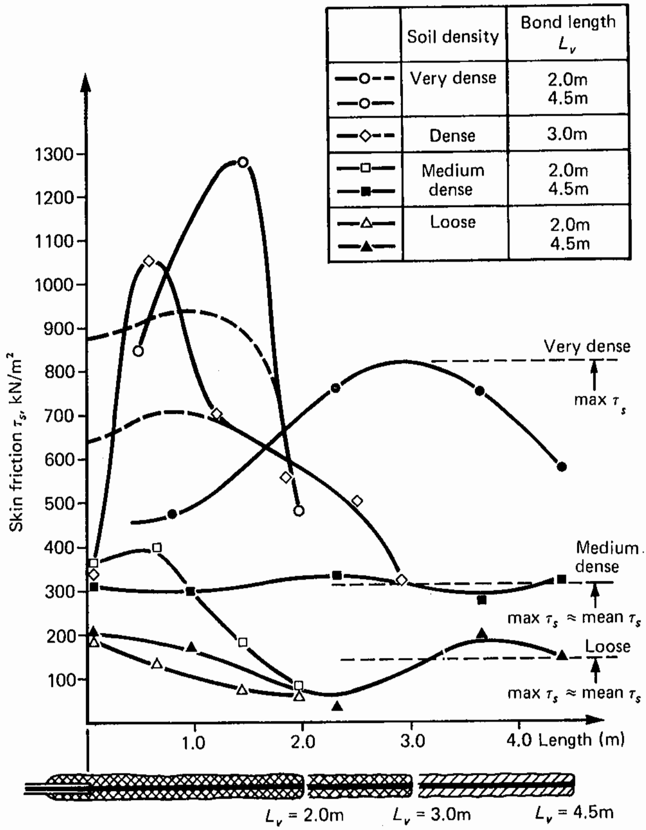


Fig. 13. Distribution of long-term friction τ_s at ultimate load in relation to tendon bond length and soil density (D = 91 – 126mm in gravelly sand)

clay (c_u = 270kN/m²) at Taranta, Southern Italy[32], have indicated similar values of α = 0.28-0.36. For stiff to very stiff marls (c_u = 287kN/m²), at Leicester in England, values of 0.48-0.60 have been monitored, although α = 0.45 is suggested for design[10]. A value of α = 0.45 has also been confirmed for stiff clayey silt (c_u = 95kN/m²) in Johannesburg[33]. Anchorages of Type *A* are generally of low capacity, and various construction methods have been attempted[10, 25], including the use of explosives in London Clay at Herne Bay[31] as early as 1955, in order to increase resistance to withdrawal. The most successful method to date in terms of ultimate load-holding capacity is the multi under-reamed Type *D* anchor which was developed from the field of piling.

Under-reaming of pile bases was pioneered in locations such as Texas, USA, the Orange Free State in South Africa[34] and India[35, 36] where severe foundation problems in expansive soils were experienced. Of particular note is the development of single, double and multi under-ream piles which has taken place at the Central Building Research Institute at Roorkee dating from 1955. In design terms the result of this work[36] includes (*i*) development of equations for estimating ultimate bearing capacity, (*ii*) confirmation that under-reamed piles act similarly in tension or compression, and (*iii*) optimisation of the under-reamed spacing/

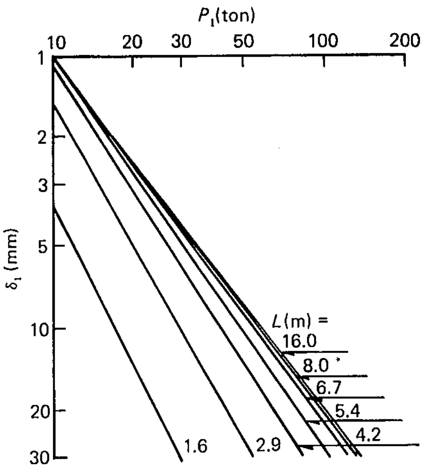


Fig. 14. Effect of fixed anchor length on load (P) – displacement (δ_1) relationship

diameter ratio at 1.25-1.50.

Following the pioneering work in piling, retaining wall tie-backs in the form of single under-ream tension piles ($D = 600$-900mm, $d = 300$mm) were installed in soft shales and very stiff clays in the United States[37] from 1961 and rapidly developed commercially[38] from 1966. In the same year, small diameter under-reamed anchors ($D = 250$mm, $d = 75$mm), using a mechanical expanding flight under-reaming tool, were already being successfully installed in clay at Westfield Properties in Durban[31, 39] to give safe working loads of up to 340kN with a 4m fixed anchor. In England high capacity multi-under-reamed anchors were extensively developed from 1967 in stiff clays and marls, which resulted in the use of eqn. *12* for design[10]:

$$T_f = \pi D L c_u + \frac{\pi}{4} (D^2 - d^2)\, N_c\, c_u + \pi\, d l\, c_a \qquad \dots (12)$$

The rule was proved initially in London Clay at Lambeth ($c_u = 134$–168kN/m^2), for the following dimensions, using a brush under-reamer

Diameter of under-ream	(D)	= 350 – 400mm (2.5 – 3d)
Diameter of shaft	(d)	= 130 – 150mm
Fixed anchor length	(L)	= 3.1 – 7.6m
Shaft length	(l)	= 1.5 – 3m

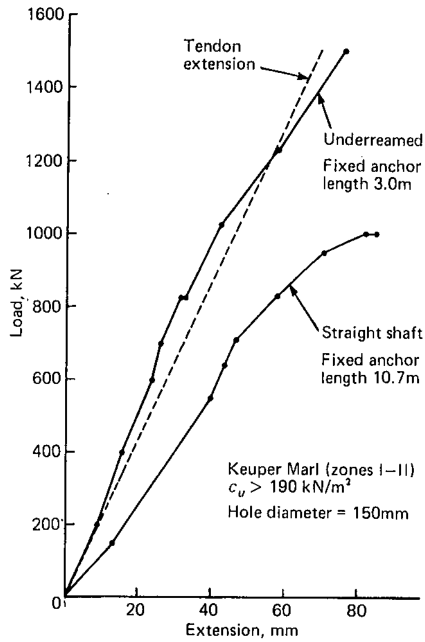


Fig. 15. Comparison of load-extension responses of an under-reamed anchor and a straight shaft anchor

Shaft adhesion	(c_a)	= (0.3–0.35) c_u based on shaft tests
Bearing capacity factor	(N_c)	= 9 (assumed from bored pile experience in London Clay)

In the absence of results from test anchors in the field, multiplier reduction coefficients ranging from 0.75 to 0.95 are commonly applied to the side shear and end-bearing components of eqn. *12* to allow for disturbance and softening of the soil which may occur during construction In the particular case where the clay adjacent to the fixed anchor contains open or sand filled fissures, a reduction coefficient of 0.5 is recommended for the side shear and end-bearing components.

Of vital importance also in cohesive deposits is the time during which drilling, under-reaming and grouting take place. This should be kept to a minimum in view of the softening effect of water on the clay. The consequence of delays of only a few hours include reduced load capacity and significant short-term losses of prestress.

With regard to spacing of under-reams (δl), eqn. *14* can be used to estimate the maximum allowable spacing to give failure along a cylindrical surface[10].

$$\pi D\,\delta l\,c_u < \frac{\pi}{4}(D^2 - d^2)\,N_c\,c_u \quad (13)$$

$$\text{i.e.} \quad \delta l < \frac{(D^2 - d^2)}{4D} N_c \quad \ldots (14)$$

For example, if $D = 400$mm, $d = 150$mm and $N_c = 9$, then $\delta l = 0.77$m. Quite independently, a similar design approach was developed in London Clay at Orford Ness[14] ($c_u = 54-72$kN/m^2) where Type *D* anchors were constructed using a mechanically expanded double flight under-reamer (see eqn. *15*):

$$T_f = \pi DL f_u c_u + \frac{\pi}{4}(D^2 - d^2)(N_c c_{u\,\text{end}} + \sigma'_E) + \pi\, dl f_s c_{u\,\text{shaft}} \quad \ldots (15)$$

where $f_u = 0.75 - 0.95$
$f_s = 0.3 - 0.6$
$N_c = 6.5$ (range 6 – 13 or greater)
σ'_E = effective stress normal to proximal end.

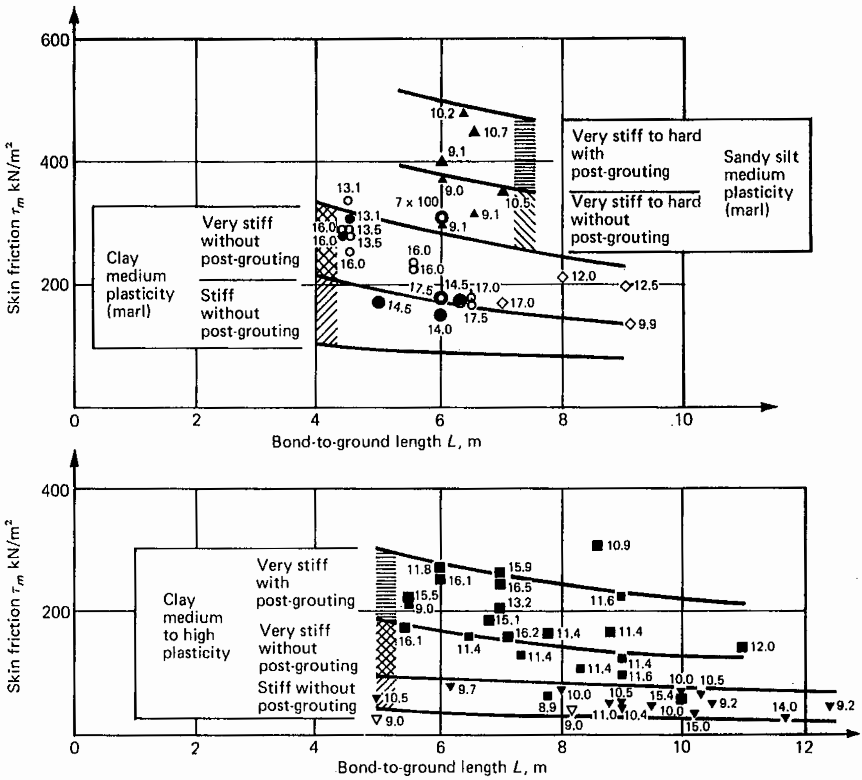
The anchor dimensions on site were *D* (460 – 530mm), *d* (140mm) *L* (3m) and *l* (7.6m). In regard to under-ream spacing it is stipulated that $\delta l \not> (1.5-2)\,D$ and $d \not> (0.6 - 0.7)\,D$ in order to ensure cylindrical shear failure. For stiff to very stiff fissured silty clay ($c_u = 130-290$kN/m^2) at Neasden Underpass, London, with a mean value of 175kN/m^2 assumed for design, test results[40] for a multi-flight mechanical under-reamer ($D = 540$mm, $d = 175$mm) have indicated an efficiency factor $f_u = 0.75$.

The success of multi under-reamed anchors over straight shafts can perhaps be illustrated best[41] by reference to Fig. 15. Based on the same augered hole diameter of 150mm, the straight shaft Type *A* anchor with a fixed anchor length of 10.7m failed at 1 000kN, whereas the under-reamed anchor of only 3m withstood, without any sign of failure, a load of 1 500kN. The advantages have also been quantified for London Clay[42] where measurements of brushed under-reams by borehole caliper indicate *D* (363mm) and *d* (140mm) i.e. an improvement of 2.59 and test anchor back-analysis gives an adhesion factor $\alpha = 0.78$ c.f. the straight shaft α of 0.35 i.e. an improvement of 2.23. Consequently, an overall improvement of more than five times is confirmed by both examples.

As a result of tests of this type and accumulated field experience of commercial anchors, safe working loads of 500 – 1 000kN can be obtained in stiff to hard clays using the multi under-reamed anchor Type *D*, compared with 300 – 400kN using straight Type *A* anchors. These figures are based on load safety factors of 2.5 – 3.5, which are considered necessary to minimise prestress losses due to consolidation of the clay.

In general, there is still a serious shortage of field performance data for anchors in cohesive soils, and little information is available on soil strength below which under-reaming is impracticable. In the writer's experience, under-reaming is ideally suited to clays of c_u greater than 90kN/m^2, but some difficulties in the form of local collapse, or breakdown of the neck portion between the under-reams should be expected where c_u values of 60 –70kN/m^2 are recorded. Under-reaming is virtually impracticable below c_u of 50 kN/m^2.

In such circumstances, use of the high pressure Type *C* anchor, with and without post-grouting, is worthy of study. The results of a large number of fundamental tests[25] are shown in Fig. 16 which can be used as a design guide for borehole diameters of 80 – 160mm. Skin friction increases with increasing consistency and decreasing plasticity. In stiff clays ($I_c = 0.8-1.0$) with medium to high plasticity, skin frictions of 30-80 kN/m^2 are the lowest recorded, whilst the highest values ($\tau_M > 400$kN/m^2) are obtained in sandy silts of medium plasticity and very stiff to hard consistency ($I_c = 1.25$). The technique of post-grouting is also shown to generally increase the skin friction of very stiff clays by some 25-50%, although greater improvements (from 120 up to about 300kN/m^2) are claimed for stiff clay of medium to high plasticity. From Fig. 17 the influence of post grouting pressure



Failure load was reached	Failure load was not reached	Post-grouting	Type of soil	W_L %	I_p %	I_c %
▲	△	Without	Silt, very sandy (marl) medium plasticity	~ 45	~ 22	~ 1.25
▲	△	With				
•	○	Without	Clay (marl) medium plasticity	32–45	14–25	1.03–1.14
●	◯	With				
●	○	Without		36–45	14–17	1.3–1.5
●	◯	With				
	◇	Without	Silt medium plasticity	23–28	5–11	0.7–0.85
▪		Without	Clay medium to high plasticity	48–58	23–35	1.1–1.2
■		With				
▼	▽	Without		45–59	16–32	0.8–1.0

Fig. 16. Skin friction in cohesive soils for various fixed anchor lengths, with and without post-grouting

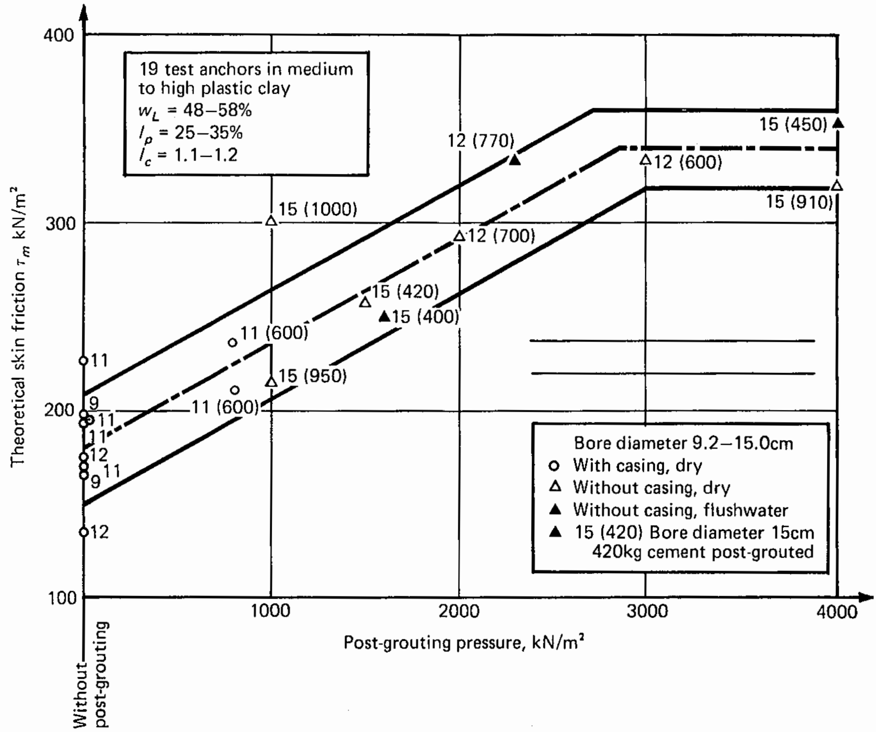


Fig. 17. Influence of post-grouting pressure on skin friction in a cohesive soil

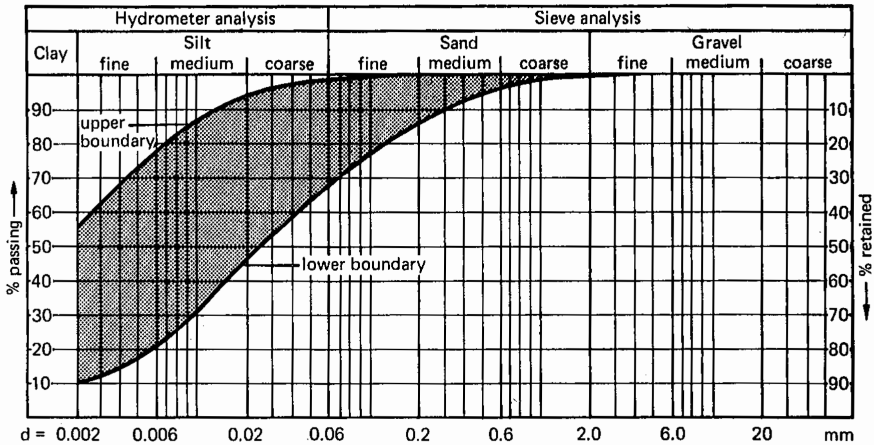


Fig. 18. Boundaries of the grain size distribution of the investigated cohesive soil

on skin friction is quantified for clays of medium to high plasticity[25], showing a steady increase in τ_M with increase in p_i.

For Type *C* anchors in cohesive soil, the Hannover analysis[29] provides eqn. *16*.

$$T_f = a_0\, a_1\, \pi\, DL + a_2\, D_1 + a_3\, D_2 + a_4\, D_3 + a_5\, D_4 + a_6\, I_c + a_7\, \tau_c \qquad \ldots (16)$$

where $\tau_c = \gamma h_m \tan \phi^1 / \cos^2 \alpha + \sin^2 \alpha\,(1 + 2 \tan^2 \phi^1) + 2 \sin \alpha \cos \alpha + c' \cos^2 \phi$

α = angle of inclination of anchor

D_1 = % soil grain d $<$0.006mm

D_2 = % soil grain 0.006mm $<$ d $<$ 0.02mm

D_3 = % soil grains 0.02mm $<$ d $<$ 0.06mm

D_4 = % soil grains d $>$ 0.06mm

I_c = consistency index

$$= \frac{LL - m}{LL - PL}$$

The multiple correlation coefficient for this equation was 0.98 and the following values for the constants have been calculated:

a_0 =	+ 721.51	a_4 =	− 21.22
a_1 =	+ 71.84	a_5 =	+ 10.34
a_2 =	− 9.81	a_6 =	+ 95.15
a_3 =	− 1.99	a_7 =	+ 2.56

Estimating the carrying capacity of ground anchors in cohesive soil by using eqn. *16*, the grain size curve must be within the boundaries of Fig. 18 and the values of the influence factors are not allowed to exceed the following limits:

$0.98m^2 \leqslant \pi DL \leqslant 6.48m^2$	$4\% \leqslant D_3 \leqslant 27\%$
$6.50cm \leqslant D \leqslant 16.80cm$	$2\% \leqslant D_4 \leqslant 34\%$
$4.10m \leqslant L \leqslant 15.00m$	$0.84 \leqslant I_c \leqslant 1.35$
$20\% \leqslant D_1 \leqslant 76\%$	$50.7kN/m^2 \leqslant \tau_c \leqslant 165.3kN/m^2$
$12\% \leqslant D_2 \leqslant 27\%$	

Distribution of shear stress

As for strong rock and dense frictional soils, the variations in measured stress in grout bonded tendons in clay, and the calculated shear stresses at the clay/grout interface can be non-linear[43, 44] both at low stress levels and at failure.

For stiff overconsolidated clay at Taranta[32] (c_u = 270kN/m² average), Fig. 19 illustrates the shear stress distribution at failure, where $E = 6.9 \times 10^4 kN/m^2$ was deduced[44].

Bearing in mind that *E* values for grout can be in the range $(1\text{-}2) \times 10^7 kN/m^2$, and that for rocks a uniform stress distribution is anticipated[12] where E_{grout}/E_{rock} exceeds 10, it is interesting to observe non-uniformity in Fig. 19, where the elastic modular ratio is well in excess of 100.

Remarks

The subject of load transfer with particular reference to the major parameters which influence stress distribution appears to warrant further study. Under failure conditions the results could indicate an upper limit to fixed anchor length (*L*). In current practice *L* seldom exceeds 10m. Under service conditions a knowledge of the stresses imposed on the clay would assist calculation of the magnitude and rate of consolidation around the fixed anchor, and hopefully improve our predictive capacity concerning loss of prestress with time. The relative importance of the tendon type e.g. bar or strand, must also be ascertained in this respect bearing in mind the greater stiffness of bars which will magnify the prestress loss in any comparitive study.

Factors of safety

When a grouted anchor fails, it must be by one of the following modes:

(*a*) Failure of the ground mass,
(*b*) Failure of the ground/grout bond,
(*c*) Failure of the grout/tendon bond, or
(*d*) Failure of the tendon or anchor head,

and in order to determine the mechanism of failure and actual safety factor for the anchor, consideration must be given to all of these aspects.

The traditional aim in designing is to make a structure equally strong in all its parts, so that when purposely overloaded to cause failure each part will collapse simultaneously.

"Have you heard of the wonderful one-hoss shay,
That was built in such a logical way
It ran for a hundred years to a day,
And then, of a sudden it . . .
. . . went to pieces all at once, —
All at once, and NOTHING FIRST, —
Just as bubbles do when they burst."

The Deacon's Masterpiece, by
Dr. Oliver Wendell Holmes.

Thus for each potential failure mechanism a safety factor must be chosen hav-

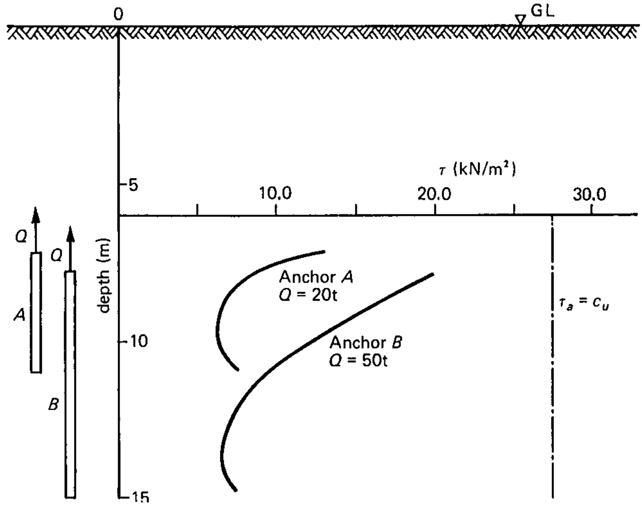


Fig. 19. Calculated shear stresses at failure

ing regard to how accurately the relevant characteristics are known, whether the system is temporary or permanent, i.e. service life, and the consequences if failure occurs i.e. danger to public safety and cost of structural damage. Since the minimum safety factor is applied to those anchor components known with the greatest degree of accuracy, the values[45] suggested in Table IV invariably apply to the characteristic strength of the tendon or anchor head.

In regard to the ground/grout interface of the fixed anchor upon which this Paper has concentrated, overall design load safety factors (S_f) range from 2-4 generally, where S_f is applied to the ultimate load-holding capacity (T_f). T_f may be defined as the constant load at which the fixed anchor can be withdrawn at a steady

TABLE IV: SUGGESTED SAFETY FACTORS FOR ANCHOR DESIGN

Anchor category	Minimum safety factor	Proof load factor
Temporary anchors where the service life is less than 6 months and failure would have few serious consequences and would not endanger public safety e.g. short term pile test.	1.4	1.1
Temporary anchors with a service life of up to 2 years, where although the consequences of failure are quite serious, there is no danger to public safety without adequate warning e.g. retaining wall tie backs.	1.6	1.25
All permanent anchors. Temporary anchors in a highly aggressive environment, or where the consequences of failure are serious e.g. temporary anchors for main cables of a suspension bridge or as a reaction for lifting heavy structural members.	2.0	1.5

rate e.g. creep in cohesive soils, or the maximum load attained prior to a distinct failure involving a sudden loss of load e.g. breakdown of bond in rock. As more poor quality ground has been exploited by anchors, so safety factors have increased in value to take account of (*i*) larger fixed anchor displacements for given load increments[46] (Fig. 20), or (*ii*) creep phenomena. In the case of (*ii*) for example, S_f values of 2-2.5 for temporary anchors in clay where the service period is less than 2 years, rise to 3-3.5 for permanent anchors, in order to keep prestress fluctuations within acceptable limits. In other words designers are quietly building in Serviceability Factors.

To avoid the growing situation where engineers simply specify the latest and largest safety factors irrespective of the ground, there is a need for a more thorough investigation of load-displacement relationships for fixed anchors in different ground conditions, since these relationships influence choice of safety factors which should be related to permissible movement as well as ultimate load. For specific ground conditions it may be possible for example to establish a correlation between a yield load giving unacceptable movement, and the ultimate load-holding capacity. Thus, if an engineer wishes to specify a factor of safety (S_y) against a yield condition, it may be feasible then to apply a modifying factor to S_y to provide an estimate of S_f for the ultimate load-holding capacity (T_f) or vice versa when T_f is estimated from an empirical equation or design envelope. This concept of safety factors may grow in importance with the advent of Limit State Codes. In an effort to encourage the analysis of test anchor results there is perhaps a case for two levels of safety factor depending on whether actual test results or calculated ultimate loads are used for design purposes.

Conclusions

Anchor construction technique and quality of workmanship greatly influence pull-out capacity, and the latter in particular limits the designer's ability to predict accurately solely on the basis of empirical rules. As a consequence the calculated figures should not be used too dogmatically in every case, since they often provide merely an indication of comparative values to the experienced designer. In anchor technology, practical knowledge is just as essential to a good design as ability to make calculations.

In 1969 at the Mexico Conference, Reporter Habib observed spectacular progress in anchoring in loose soils, but stated that it was rather odd to realise that the theories were still empirical in nature. Since empiricism in design is still prevalent today it might be argued that little progress has been made. In the author's view some sympathy must be expressed for the attitude that resists the creation and application of the more sophisticated theories, since they invariably demand accurate values of a multitude of ground and anchor parameters in order to attain the improved accuracy. In this regard, a

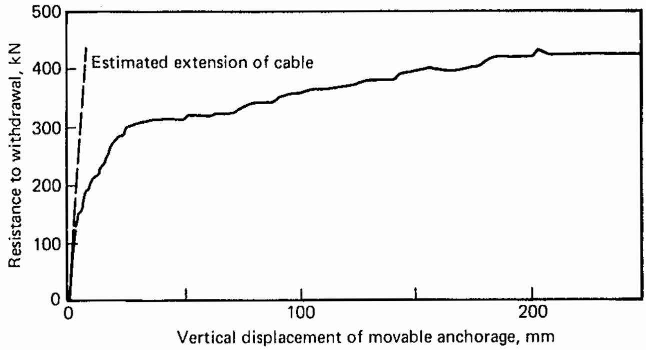


Fig. 20. Load/displacement relationship for compact fine/medium sand (ϕ = 35°)

good example is short, low capacity rock bolts where the cost of investigating the detailed variation in a heterogeneous rock mass far outweighs the cost of installation and proof-loading additional bolts, in the event of unsatisfactory performance.

In reality a period of technical consolidation has taken place over the past decade in the form of standardisation of practice combined with a steady collection of short-term test data. At the same time the world anchor market has continued to expand dramatically, and forced designers into a wider range of ground conditions, particularly poor quality materials. Design rules have been created, employed and confirmed to be satisfactory in the main over this period, and significantly but understandably most attention has been directed towards simple pull-out tests. Routine tests of this kind are of paramount importance, since the results can be used to optimise the design and construction of the anchors on a particular site, in addition to establishing actual factors of safety. In this way the validity of empirical design rules can also be checked for the different ground conditions encountered in anchorage work. In the future, more attention should be directed towards monitoring load displacement relationships and service behaviour with particular regard to loss of prestress with time in order that more confidence can be established for permanent anchors in soils and weathered rocks.

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JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS SECTION

Proceedings

AMERICAN SOCIETY OF CIVIL ENGINEERS

ANNUAL REPORT OF THE BOARD OF GOVERNMENT, 1980-1981

To the Boston Society of Civil Engineers Section,
The American Society of Civil Engineers

Pursuant to the requirements of the Bylaws, the Board of Government presents its report for the year ending April 22, 1981.

A. MEMBERSHIP

The following is a statement of membership in the Section

Honorary Members	5
Assigned ASCE Members (as of 3/81)	2176
Subscribers:	
Members	1152
Associate Members	324
Student Chapters	9

Summary of Additions

New Members	52
New Associate Members	77

Summary of Loss of Members

Deaths	12
Resignations	11
Dropped	76

Life Members

Life Members	191
Members becoming eligible April 22, 1981	4

Honorary Members

John B. Babcock, 3rd	elected	January 2, 1969
Arthur Casagrande	elected	February 1, 1975
Albert G.H. Dietz	elected	January 19, 1981
Ralph W. Horne	elected	February 1, 1965
John A. Volpe	elected	January 29, 1968

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Demetrios S. Papademetriou	August 1980
Samuel J. Tomasello	May 1980
Paul A. Wirth	May 1980

B. MEETINGS OF THE SECTION AND ITS TECHNICAL GROUPS

The Section held meetings on the following dates.

September 16, 1980	Joint Meeting with the Geotechnical Group and the Ad Hoc Energy Committee
October 8, 1980	Joint Meeting with the Environmental Group
October 16, 1980	Monthly Luncheon Meeting
November 13, 1980	Monthly Luncheon Meeting held as a Joint Meeting with the Transportation Group
December 9, 1980	Monthly Luncheon Meeting
December 10, 1980	Joint Meeting with the Computer Group
January 27, 1981	Joint Meeting with the Hydraulics Group
February 4, 1981	Joint Meeting with the Structural Group
March 26, 1981	Joint Meeting with the Construction Group

The details of the monthly luncheon meetings are contained in the Annual Report of the Monthly Luncheon Committee.

In addition to the above combined meetings with the Section, the Technical Groups held many other meetings and sponsored many lecture series. The details of the combined meetings with the Section, other meetings and lecture series are contained in the respective Annual Reports of the Technical Groups.

C. MEETINGS OF THE BOARD OF GOVERNMENT

The Board of Government met on the following dates.

May 19, 1980	at the Engineers Club
June 16, 1980	at the Section's office
September 15, 1980	at the Section's office
September 24, 1980	at the Section's office
October 20, 1980	at the Section's office
November 17, 1980	at the Section's office
December 15, 1980	at the Section's office
January 19, 1981	at the Section's office
February 23, 1981	at the Section's office
March 16, 1981	at the Section's office

For significant actions of the Board of Government, see Appendix A.

D. COMMITTEES

Committees were appointed to deal with the activities and conduct of the Section. Except for the Nominating Committee (as provided in the Bylaws) these committees were under the general direction of the Board of Government, and reported to the Board of Government. The activities of the committees are described in the respective Annual Reports of the Committees.

E. AWARDS

The Board of Government voted a number of awards at its March 16, 1981 meeting. See Appendix A, under that date for a complete listing.

F. FUNDS

The operating fund of the Section is called the Current Fund. The endowment of the Section is contained in the Permanent Fund. In addition, there are special funds established by gifts or bequests and special funds established by the Board of Government. A listing of each of these special funds, together with a description of each, is given in Appendix B.

The Treasurer's Annual Report gives the details of the status and transactions for all the funds.

Respectfully submitted,

Rubin M. Zallen, Secretary

APPENDIX A, Actions of the Board of Government

VOTED 5/19/80: That Lee Wolman of the Freeman Fund Committee and Hank Holly, Chairman of History & Heritage Committee will consider a fitting memorial to John R. Freeman in connection with the proposal of the Charles River Basin as an ASCE historic civil engineering landmark.

VOTED 6/16/80: To donate $100 to the Massachusetts Engineers Council with the proviso that the Action Program-Professional Practice Committee appoint two delegates to attend MEC meetings and report to the Board at the end of the fiscal year.

That the Membership Committee circulate a petition re establishment of an ASCE student membership grade.

VOTED 9/15/80: That actions voted by the Board of Government be compiled at the end of each year for review.

VOTED 10/20/80: To issue membership cards to dues-paying members.

To distribute membership lists to Technical Group Chairmen.

To revise Articles of Incorporation according to suggestions of the IRS.

To combine Student Night with the BSCES Annual Meeting in 1981.

To approve Ad Hoc Energy Committee's energy policy statement.

To endorse Murray McPherson as Honorary ASCE member.

To refer recommendations of the Membership Committee re Affiliate and Jr. Affiliate grades of membership to the Constitution and Bylaws Committee for study.

To accept the budget for fiscal 1981-1982 as proposed by the Treasurer.

VOTED 11/17/80: That $2,000 of $6,000 surplus realized by the 1979 ASCE Convention Committee be put in an escrow account, together with the balance of Convention Committee account for use in planning the next convention held in Boston.

That the remaining $4,000 be invested and yearly income be put at the disposal of Student Affairs Committee, with the use of the income subject to Board approval.

VOTED 12/15/80: To tentatively accept the Publications Committee's recommendation to reduce the BSCES Journal from 4 issues to 2 issues a year and notify the membership via the Newsletter of this intention.

To contribute $1,000 to M.I.T.'s Rock Mechanics Symposium upon receipt of written request.

VOTED 1/19/81: To ask the Social Functions Committee to consider an activity other than a Dinner Dance for 1981-1982 social event.

VOTED 2/23/81: To elect Albert G.H. Dietz as an Honorary Member of the Section.

VOTED 3/16/81: To reduce publication of BSCES *Journal* from four times a year to twice a year.

To present the 1981 Ralph W. Horne Award to Dr. Harl P. Aldrich.

To present the Geotechnical Group Award for 1981 to William S. Zoino and Nicholas A. Campagna, co-authors of Journal paper, "Engineering Behavior of the Taunton River Clays".

To present the 1981 Howe-Walker Student Awards to the following:

Paul R. Marcus	MIT
Nora Daghlian	Merrimack
Bruce T. Magley	Northeastern (Div. A)
Mark D. Evans	Northeastern (Div. B)
John F. Buckley, Jr.	Southeastern Mass. Univ.
Gaye A. Cicalis	Tufts
Wayne J. Gordon	Lowell
Carolyn M. Gorczyca	UMass
Susan L. Hoffma	Worcester Polytechnic
Kenneth F. Johnson II	Wentworth

To present the 1981 Desmond Fitzgerald Scholarship Award to Ralph D. Nelson (Northeastern University).

To present the 1981 William B. Morse Scholarship Award to Patricia McCarry (Tufts University).

To award a $1,000 student loan to each of the following:

Carol Jayne Lemb	Northeastern University
Lissa M. Sarro	Northeastern University

VOTED 4/16/81: (by telephone poll of Board of Government)
To accept the recommendation of the Jury of Judges of the Massachusetts Outstanding Civil Engineering Achievement Award Committee to award to SEA Consultants of Boston the 1981 Award of Merit for their project, "Water Supply Improvements in Cohasset, Massachusetts."

APPENDIX B, Special Funds

JOHN R. FREEMAN FUND. In 1925 the late John R. Freeman, a Past President and Honorary Member of the Boston Society of Civil Engineers, made a gift to the Society of securities which were established as the "John R. Freeman Fund." The income from the Fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to the hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to the Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, a report of which would be presented to the Society.

EDMUND K. TURNER FUND. In 1916 the Society received a bequest of $1,000 from Edmund K. Turner, a former member, the income of which is to be used for library purposes.

ALEXIS H. FRENCH FUND. A bequest of $1,000 was received in 1931 from the late Alexis H. French, a Past President of the Society. The income from the Fund is "to be devoted to the Library of the Society."

CLEMENS HERSCHEL FUND. This Fund was established in 1931 by a bequest of $1,000 from the late Clemens Herschel, a Past President and Honorary Member of the Society. The income from the Fund "is to be used for the presentation of prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgement."

DESMOND FITZGERALD FUND. The Desmond Fitzgerald Fund, established in 1910 by a bequest of $2,000 from the late Desmond Fitzgerald, a Past President and Honorary Member of the Society, provided that the income from this Fund "shall be used for charitable and educational purposes." The Board voted on April 13, 1964 to use the income of this Fund to establish a Boston Society of Civil Engineers' Scholarship in Memory of Desmond Fitzgerald, and that it be given to a student in Civil Engineering at Northeastern University.

RALPH W. HORNE FUND. This Fund, a bequest of $3,000, was received June 29, 1964, from the Directors of Fay, Spofford and Thorndike, Inc., the income from which shall be devoted to a prize or certificate to be awarded annually to a BSCE member designated by the Board of Government to have been outstanding in unpaid public service in municipal, state or federal elective or appointed posts, or in philanthropic activity in the public interest.

HOWE-WALKER FUND. This Fund was created by a vote of the Board of Government and combines the Edward R. Howe Fund and the Frank B. Walker Fund. Income from this joint Fund is used to help defray costs of student awards.

WILLIAM P. MORSE FUND. This Fund, a bequest of $2,000, was received in 1949 from the late William P. Morse, a former member of the Society. No restrictions were placed on the use of this bequest but the recommendation of the Board of Government was "that the Fund be kept intact, and that the income be used for the benefit of the Society and its members." Upon recommendation of the Committee appointed by the President, the Board voted on April 5, 1954 "to appropriate from the income of this Fund a scholarship to be known as the Boston Society of Civil Engineers' Scholarship in Memory of William P. Morse, and that it be given to a Civil Engineering student at Tufts University.

THOMAS R. CAMP FUND. This Fund, a bequest of $10,000, was received January 15, 1971 from the Directors of Camp, Dresser & McKee, Inc. to establish the "Thomas R. Camp Fund", the income to be used to support an annual Thomas R. Camp lecture or lectures on outstanding recent developments or proposed or completed research in the sanitary engineering field. The income from the Fund, over and above that needed to support the annual lecture, should be added to the Fund, but could be used otherwise at the discretion of the Board of Government of the Boston Society of Civil Engineers Section of the American Society of Civil Engineers.

LECTURE FUND. The Lecture Fund was established in 1969 for the purpose of providing money for special lectures sponsored by the Society.

KARL R. KENNISON FUND. This Fund comprised two irrevocable trusts established on behalf of the Society by Karl R. Kennison. These trusts consist of shares of the Massachusetts Fund, The Massachusetts Company, Inc., trustees. After Mr. Kennison's death net income shall be paid to the Society for a Hydraulics Lecture Fund to be used for various public lectures on this subject and the Board may withdraw the principal on written demand or make changes in the use of the Fund as it may determine are warranted. The Investment Committee has recommended to the Board of Government that the funds be consolidated with the principal funds in one location.

CONVENTION FUND. This Fund was established by the Board of Government on November 17, 1980 with an initial principal amount of $2,000 from the surplus realized by the 1979 ASCE Convention Committee. This Fund will be used for the planning of the next ASCE national convention in Boston.

STUDENT AFFAIRS FUND. This Fund was established by the Board of Government on November 17, 1980 with an initial principal amount of $4,000 from the surplus realized by the 1979 ASCE Convention Committee. The annual income from this fund will be at the disposal of the Student Affairs Committee, with its use subject to the approval of the Board of Government.

STUDENT LOAN FUND. An interest-free loan of $1,000, repayable in four years following graduation, may be made to a deserving member of a Student Chapter or Club in the Section area. Up to two loans may be made annually. Donations to the Student Loan Fund are solicitated annually from area firms by the Student Affairs Committee.

ROGER GARDNER MEMORIAL FUND. This Fund was established at the request of the Student Affairs Committee. At the December 17, 1979 meeting of the Board of Government it was voted to present a certificate and a sum of money to be later determined to a deserving student. Funds for the certificate and cash award to be raised by solicitations made to BSCES members-at-large and area firms.

LEROY G. BRACKETT FUND. This Fund was established on January 30, 1978 from a bequest made by Donald F. Brackett. No formal recommendation for the use of the Fund has as yet been voted by the Board of Government.

MINUTES OF THE ANNUAL MEETING OF THE SECTION

Part I

April 21, 1981. Part I of the 133rd Annual Meeting of the Boston Society of Civil Engineers (the seventh meeting of the Boston Society of Civil Engineers Section following the merger of the BSCE with the Massachusetts Section of ASCE) was held at the offices of Camp, Dresser & McKee, Inc. in Boston. The meeting was called to order at 3:00 p.m. by President Frank E. Perkins.

Executive Director Susan Albert distributed the Annual Report of the Board of Government.

Norman W. Bennett presented the Annual Report of the Treasurer.

Secretary Rubin M. Zallen called for reports from the following Committees: Action Program-Professional Practice, Advertising, Annual Meeting, Auditing, Awards, Constitution and Bylaws, Thomas R. Camp Fund, Continuing Education, Employment Conditions, Energy, John R. Freeman Fund, History and Heritage, Investment, Key Man, Lecture Series, Membership, Monthly Luncheon, Nominating, Operations Manual, Program, Public Relations, Publications, Social Affairs, Student Activities. Also for reports of Technical Groups: Computer, Construction, Environmental, Geotechnical, Hydraulics, Structural, Transportation. The report of the Western Branch was also presented.

Vice President Edward B. Kinner moved that Committee and Technical Group reports be accepted and placed on file. It was seconded and so VOTED.

Former ASCE Zone I Vice President and long time member of the BSCE Section, Cranston R. Rogers, announced that he is leaving the Boston area and addressed a few remarks to the Board in praise of the Section and expressing his regret at leaving.

Dr. Harl P. Aldrich, recipient of the 1981 Ralph W. Horne Award, expressed his appreciation at being chosen to receive the Award.

President Perkins presente Certificates of Appreciation to the retiring Technical Group Chairmen.

President Perkins concluded the meeting's program by presenting his retiring address, which is to be printed in the BSCES Journal.

Part II

April 22, 1981. Part II of the 1981 BSCE Section's Annual Meeting was held at the John F. Kennedy Library in Dorchester. This event combined the BSCES Annual Meeting with the 1981 Student Night. President Perkins reconvened the meeting at 8:25 p.m., following a film, tour of the Library and dinner. President Perkins called upon Secretary Zallen to assist in the awarding of prizes and certificates to Life Members, which were in turn presented by the President.

An award for a technical paper was as follows: (this was the only award for a technical paper voted this year by the Board of Government):

Geotechnical Group Award
Recipients: William S. Zoino and Nicholas A. Campagna, Jr. for their paper *Engineering Behavior of the Taunton River Clays.*

The following persons were awarded Certificates of Appreciation for their services to the Section:

Norman W. Bennett - BSCES Treasurer - 1979-1981
Peter K. Taylor - BSCES Director - 1979-1981
Paul J. Trudeau - BSCES Director - 1979-1981

Certificates of Appreciation were also presented on behalf of ASCE National to:

Ronald C. Hirschfeld - Chairman, Committee on Integration of Education and Practice
Russel C. Jones - Chairman, Technical Council on Research
Thomas K. Liu - Chairman, Committee on Sections and District Councils
Ernest T. Selig - Secretary, Geotechnical Engineering Division

President Perkins presented Dr. Harl P. Aldrich with the Ralph W. Horne Award for 1981.

Chairman of the Student Activities Committee, Michael Kupferman, presented the 1981 Student Awards: Howe-Walker Awards to: Paul R. Marcus of MIT, Nora Daghlian of Merrimack, Bruce T. Magley of Northeastern Div. A, Mark D. Evans of Northeastern Div. B, John F. Buckley Jr. of Southeastern Mass., Gaye A. Cicalis of Tufts, Wayne J. Gordon of Lowell, Carolyn M. Gorczyca of UMass, Susan L. Hoffma of Worcester Polytechnic, and Kenneth F. Johnson II of Wentworth. The Desmond Fitzgerald Award was presented to Ralph D. Nelson of Northeastern; the William B. Morse Award to Patricia McCarry of Tufts. Student loans were awarded to Carol Jayne Lemb and Lissa M. Sarro, both of Northeastern.

Northeastern University was presented with ASCE National's Robert Ridgway Student Chapter Award for 1980. Northeastern's Student Chapter also received an ASCE National Certificate of Commendation. Merrimack College, Southeastern Massachusetts University and the University of Massachusetts each received an ASCE Letter of Honorable Mention.

ASCE National Director for District 2, S. Russell Stearns, announced that Northeastern University has also been awarded the Robert Ridgway Award for 1981. This will be Northeastern's fifth consecutive Ridgway Award.

Stearns also presented President Perkins with ASCE's 1980 Presidential Citation.

Brief biographies of newly elected ASCE and BSCE Section Life Members were distributed, and President Perkins presented certificates to those present. New ASCE Life Members were as follows: John S. Bethel, Norman B. Cleveland, Daniel H. Conlin, George Grantham, Charles K. Knapp, Charles F. Sullivan, William F. Swiger and Harold A. Thomas. Perkins also recognized those members who became ASCE Life Members in 1980 but were not recognized at the 1980 BSCES Annual Meeting. They include: Harry Balmer, Joseph N. Caruso, John B. Elliot, John A. Fellouris, Michael Gold, Richard A. Greeley, George Hankinson, Stephen Haseltine, Richard W. Stewart, Jerome Swartz, Kentaro F. Tsutsumi and Louis W. Wise. New BSCE Section Life Members were: Thomas T. Amirian, George W. Hankinson, Alfred Harriman and John J. Jarnis.

President Perkins presented to Dr. Albert G.H. Dietz a Certificate of Honorary Membership in the BSCE Section.

President Perkins read the names of members who died during 1980-1981: Herbert J. Albee, Robert J. Basso, Edmund H. Brown, Anthony S. Coombs, Carl C. Enebuske, Edward K. Hull, Albert S. Kaufman, John P. Kennedy, Demetrios S. Papademetriou, Samuel J. Tomasello, Paul A. Wirth and former BSCES Executive Director, Charlotte E. Dalrymple. A moment of silence was observed.

The Award of Merit for Massachusetts Outstanding Civil Engineering Achievement was presented to SEA Consultants of Boston for their project, "Water Supply Improvements Program for Cohasset, Massachusetts."

The results of the election of the Nominating Committee Members was announced. They are Domenic D'Eramo and Saul Namyet. A tie vote was cast in the election of the third member. New ballots will be mailed to break the tie.

President Perkins then turned over the gavel to incoming President Edward B. Kinner, whose first act was to present a plaque and past president's pin to retiring President Perkins commemorating his year as president. President Kinner briefly outlined his goals for his term in office and introduced the 1981-1982 officers and directors: Vice Presidents Stanley C. Rossier and Richard J. Scranton, Secretary Rubin M. Zallen, Treasurer Richard F. Murdock and Directors Judith Nitsch Donnellan, Rodney P. Plourde, Warren H. Ringer and John P. Sullivan.

President Kinner then introduced the guest speaker, noted author David McCullough, who addressed the subject "Engineering Creativity and the Professor's Pickled Fish: Attitudes Towards Teaching and Learning."

Two hundred eighty members and guests attended the dinner and evening meeting.

ANNUAL REPORT OF THE TREASURER

October 1, 1980

For The Fiscal Year October 1, 1979 to September 30, 1980

FISCAL STANDING

The Fiscal Standing of the Section is summarized in the four tables which accompany this report:

Table I - Condensed Statement of Condition
Table II - Condensed Statement of Income and Expenditures
Table III - Detailed Statement of Income and Expenditures
Table IV - Portfolio of Investments and Projected Yield

SECTION INVESTMENT

The Boston Safe Deposit and Trust Company continues as custodian of our portfolio of securities and has furnished us with an annual summary account. The Custodian continues to make portfolio changes and reports quarterly on the portfolio performance. During this year the Custodian was authorized to reinvest all income from the principal account.

SECTION BANK DEPOSITS

All non-invested cash is deposited into a Suffolk Franklin NOW Account. The NOW Account is an interest bearing checking account. The fiscal year record was:

	Debit	*Credit*	*Balance*
Balance 10/1/79			$ 8,005.00
Deposits 10/1/79-9/30/80		$119,388.00	
Interest		1,289.00	
Checks Drawn	$118,533.00		
Bank Charges	13.00		
Totals	$118,546.00	$120,677.00	$10,136.00

PERMANENT FUND

The Permanent Fund receives its prorated portion of investment income and all entrance fees for the local Section membership. A prorated portion of custodial service charge is debited.

	Debit	*Credit*	*Balance*
Book Value 10/1/79			$100,534.00
Custodian Service	$1,035.00		
Interest, Dividends, Transactions		$12,457.00	
Entrance Fees		545.00	
Transfer to Current Fund			
Totals	$1,035.00	$13,002.00	$112,501.00

TECHNICAL GROUP LECTURE SERIES FUNDS 1977-78-79-80

Geotechnical Group - Soil Dynamic Lecture Series (1977-78)

Income	$16,686
Expense	$13,450
	$ 3,236

50% Available for Approved Expenditures	$1,618.00
Expended by Geotechnical Group in 1978-79	$1,542.00
Available for Approved Expenditures (1979-80)	$ 76.00
Expended by Geotechnical Group in (1979-80)	$ 483.00
Negative Surplus	-$ 407.00

Geotechnical Group-Embankment Dams Lecture Series (1979-80)

Income	$19,808
Expense	$11,405
	$ 8,403

50% Available for Approved Expenditures	$4,201.00
Negative Surplus Brought Forward	$ 407.00
Available for Approved Expenditures (1980-81)	$3,794.00

Structural Group - Renovation and Rehabilitation of Existing Buildings - (1979-1980)

Income	$14,473.00
Expense	$ 8,346.00
	$ 6,127.00

50% Available for Approved Expenditures	$3,063.00
Expended by Structural Group in (1979-80)	$ 970.00
Available for Approved Expenditures (1980-81)	$2,093.00

Environmental Group - Camp Lecture Series (1979-80)

Income	$6,705.00
Expense	$4,257.00
	$2,448.00

50% Available for Approved Expenditures (1980-81)	$1,224.00

TECHNICAL GROUP FISCAL OPERATIONS 1979-80

	Income	*Expense*	*Surplus*	*Deficit*
Computer	$ 0.00	$ 53.00	$ -	$ 53.00
Construction	976.00	1,180.00	-	204.00
Environmental	13.00	0.00	13.00	-
Geotechnical	4,019.00	4,503.00	-	484.00
Hydraulics	93.00	47.00	46.00	-
Structural	0.00	970.00	-	970.00
Transportation	0.00	33.00	-	33.00
	$5,101.00	$6,786.00	$59.00	$1,744.00

Respectfully submitted
Norman W. Bennett, Treasurer

TABLE I

CONDENSED STATEMENT OF CONDITION
Assets, Liabilities and Funds

	BOOK VALUE		MARKET VALUE	
ASSETS	9-30-80	10-1-79	9-30-80	10-1-79
Suffolk Franklin NOW	$ 10,036.00	$ 8,005.00	$ 10,036.00	$ 8,005.00
Boston Safe Deposit:				
Bonds	106,807.00	106,656.00	86,661.00	92,795.00
Stocks	108,980.00	81,627.00	142,493.00	108,226.00
Cash	65,749.00	64,531.00	65,749.00	64,531.00
Boston Safe Deposit Total	$281,536.00	$252,814.00	$294.903.00	$265,552.00
Total Assets	$291,572.00	$260,819.00	$304,939.00	$273,557.00
LIABILITIES AND FUNDS				
Permanent Fund	$112,501.00	$100,534.00	$117,817.00	$105,600.00
Freeman Fund	85,256.00	78,032.00	89,381.00	81,963.00
Turner Fund	4,871.00	4,374.00	5,103.00	4,595.00
Fitzgerald Fund	7,406.00	6,830.00	7,767.00	7,174.00
French Fund	4,819.00	4,327.00	5,047.00	4,545.00
Herschel Fund	3,051.00	2,774.00	3,197.00	2,913.00
Howe Fund	5,188.00	4,754.00	5,440.00	4,994.00
Morse Fund	6,797.00	6,283.00	7,129.00	6,600.00
Walker Fund	2,258.00	2,069.00	2,368.00	2,174.00
Horne Fund	6,598.00	5,925.00	6,911.00	6,223.00
Lecture Fund	6,170.00	6,170.00	6,496.00	6,481.00
Camp Fund	17,136.00	15,388.00	17,950.00	16,163.00
Bracket Fund	361.00	324.00	378.00	340.00
Kennison Fund	11,097.00	9,965.00	11,624.00	10,467.00
Invested Current Fund	7,947.00	5,065.00	8,215.00	5,320.00
Roger Gardner Fund	80.00		80.00	
Total Invested Funds	$281,536.00	$252,814.00	$294,903.00	$265,552.00
Continuing Education Fund	$ 7,762.00	$ 7,022.00	$ 7,762.00	$ 7,022.00
Boring Data Fund	1,596.00	1,596.00	1,596.00	1,596.00
Student Loan Fund	1,909.00	1,304.00	1,909.00	1,304.00
Group Lectures	7,111.00	8,644.00	7,111.00	8,644.00
Corpus	(8,242.00)	(10,561.00)	(8,242.00)	(10,561.00)
Total Liabilities	$ 10,136.00	$ 8,005.00	$ 10,136.00	$ 8,005.00
Total Liabilities and Funds	$291,572.00	$260,819.00	$294,903.00	$273,557.00

TABLE II — CONDENSED STATEMENT OF INCOME AND EXPENDITURES — DISTRIBUTION OF INVESTED FUNDS

Fiscal Year October 1, 1979 - September 30, 1980

FUND NAME	*Book Value 10-1-79*	*Change in Book Value from Transactions, Interest, Dividends*	*Receipts*	*Transfer TO*	*Transfer FROM*	*Custodian Charges*	*Expen-ditures*	*Book Value 9-30-80*
Permanent	$100,534	$12,457	$545	$	$	$1,035	$	$112,501
Freeman	78,032	9,668				803	1,641	85,256
Turner	4,374	542				45		4,871
Fitzgerald	6,830	846				70	200	7,406
French	4,327	537				45		4,819
Herschel	2,774	344				29	38	3,051
Howe	4,754	589				49	106	5,188
Morse	6,283	779				65	200	6,797
Walker	2,069	256				21	46	2,258
Horne	5,925	734				61		6,598
Lectures	6,170	764				63	701	6,170
Camp	15,388	1,906				158		17,136
Bracket	324	40				3		361
Kennison	9,965	1,235				103		11,097
Inv. Current	5,065	627		2,307		52		7,947
Roger Gardner	0	0	115	0	0	0	35	80
Totals	$252,814	$31,324	$660	$2,307	0	$2,602	$2,967	$281,536

DISTRIBUTION OF MISCELLANEOUS FUNDS

	Book Value 10-1-79	*Receipts Fiscal Year*	*Expenditures Fiscal Year*	*Book Value Before Transfers*	*Transfers*	*Book Value 9-30-80*
Continuing Education Fund	$ 7,022	$ 3,750	$ 3,010	$ 7,762	-	$ 7,762
Boring Data Fund	1,596	-	-	1,596	-	1,596
Student Loan Fund	1,304	2,605	2,000	1,909	-	1,909
Group Lecture Series	8,644	40,986	24,008	25,622	(18,511)	7,111
Dinner Dance	0	462	1,553	(1,091)	1,091	0
Clambake	0	3,955	3,674	281	(281)	0
Technical Group Meeting	0	5,101	6,788	(1,687)	1,687	0
Entrance Fees	0	545	-	545	(545)	0
Current	0	63,273	77,513	(14,240)	14,240	0
Corpus	(10,561)	·0	0	(10,561)	2,319	(8,242)
Totals	$8,005	$120.677	$118,546	$10,136	$ 0	$10,136

TABLE III
DETAILED STATEMENT OF INCOME AND EXPENDITURES
Fiscal Year 10-1-79 to 9-30-80

	Expenditures	*Income*
Dues	$	$ 23,664
Allotment		3,667
ACEC/NE Reimbursement		15,175
Bank Interest		1,289
Entrance Fees		545
Administration Salaries	14,549	
Secretarial Salary	1,287	
Taxes	7,197	
Personnel Annuity	1,585	
Insurance	182	
Rent	1,901	
Telephone	611	
Postage	2,992	
Office Services	275	
Office Supplies	1,193	64
Petty Cash	308	
Staff Insurance	292	
Office Copier	463	
Electricity	198	
Journal Printing	21,053	1,930
Newsletter	1,610	
Monthly Notice	3,523	45
Advertising		70
Publication Sales	4	2,477
Reprints	413	453
General Printing	1,078	35
Annual Meeting	3,758	1,907
Dinner Dance	1,553	462
Clambake	3,675	3,955
Awards	82	
Local Society	100	
Branch Activity	250	
ASCE Conference	15	
1979 Convention	1,200	10,419
Computer Group	53	
Construction Group	1,180	976
Environmental Group		13
Geotechnical Group	4,503	4,019
Hydraulics Group	47	93
Structural Group	970	
Transportation Group	33	
Camp Lecture Series	4,257	6,705
Continuing Education	3,010	3,750
Freeman Lecture Series	641	
Geotechnical Lecture Series	11,405	19,808
Structural Lecture Series	8,346	14,473
Student Loan	2,000	2,605
Student Night	1,992	892
Student Activities	1,221	
Leadership Training	76	
Roger Gardner Memorial	35	115
Legislative Affairs	1,685	
Membership Committee	540	
Monthly Luncheon	50	37
Miscellaneous	141	869
Energy	338	
Public Relations	40	
Freeman Fund	1,000	
General Contingency	3,536	165
MEC	100	
	$118,546	$120,677

TABLE IV

PORTFOLIO OF INVESTMENTS - SEPTEMBER 30, 1980

Description	*Book Value*	*Market Value*	*Estimated Income*
CASH			
Cash	$ 1,031	$ 1,031	$ 0
Savings Accounts	16,000	16,000	1,431
U.S. Treasury Bills	48,718	48,718	3,700
Total Cash	$ 65,749	$ 65,749	$ 5,131
BONDS			
U.S. Government Notes	$ 10,050	$ 9,231	$ 788
Federal Agencies	55,227	48,863	4,865
Utility	16,005	9,445	875
Industrial	10,450	9,506	462
Financial	5,000	2,972	250
Foreign	10,075	6,644	600
Total Bonds	$106,807	$ 86,661	$ 7,840
COMMON STOCK			
Aerospace and Aircraft	$ 8,593	$ 10,200	$ 440
Chemical	13,047	15,512	680
Drug, Hospital, Dental Supply	20,158	22,131	722
Electronic & Electrical Supply	8,421	7,894	450
Finance	9,124	10,838	600
Food, Beverage, and Allied Products	9,592	8,288	444
Machinery & Machine Tools	4,090	7,375	120
Office Equipment	8,431	11,543	619
Oil and Gas	6,489	17,925	1,000
Retail Trade	6,824	8,625	216
Tobacco	7,241	10,531	400
Utilities	6,970	11,631	1,198
Total Common Stock	$108,980	$142,493	$ 6,889
Grand Total	$281,536	$294,903	$19,860

ANNUAL REPORTS OF COMMITTEES

Report of Action Program - Professional Practice Committee, 1980-1981

The membership of the committee includes:

Domenic E. D'Eramo, Chairman	Transportation
Marvin Miller	Transportation
Dr. Gonzalo Castro	Computer
Dr. Mukti Das	Computer
John T. Quinn	Construction
Robert H. Stewart	Environmental
Burton A. Segall	Environmental
William C. Day	Geotechnical
James Weaver	Geotechnical

The committee continues to be most active in the area of government regulations and legislation. Through the "Design Professional Joint Government Affairs Council", we have been made aware and reacted with other societies on legislation and regulations affecting the Society. As part of the Massachusetts Engineers Council, we have participated in supplying the legislature with accurate scientific and engineering information and expertise.

During the course of the year, the committee has been involved in other miscellaneous activities.

Respectively submitted,
D.E. D'Eramo, Chairman

Report of Advertising Committee, 1980-1981

The activities of the Advertising Committee during the past year were principally in the following areas:

1. Servicing and reinvoicing of 53 percent *Journal* advertisers.

2. Preparation and mailing of a letter to present *Journal* advertisers indicating that the format of the *Journal* is to be improved in the manner recommended by the Publications Committee and in the future two issues will be published per year instead of four.

3. Letters were sent to approximately 35 advertisers in the "Special Edition" of the *Journal* printed in January 1979 for the ASCE National convention in Boston.

4. Preparation and mailing of letters to approximately 120 potential new advertisers, mainly consulting firms in the Boston area.

It is recommended that the results of the recent mail solicitation be evaluated in the Fall of 1981 and that a telephone campaign be undertaken by the Advertising Committee to follow up on the mailings and obtain new advertisers for the *Journal.*

Respectfully submitted,
William S. Zoino, Chairman

Report of Auditing Committee, 1980-1981

A special audit was conducted of the Society's financial records prior to the annual meeting, for the fiscal year period through February 28, 1981. This audit consisted of a review of the bank statement's cash balance as of February 28, 1981 compared to the Treasurer's most recent monthly cash statement. This audit indicated the difference of less than $2.00 between the bank's and Treasurer's statements. The Audit Committee, therefore, concluded that the Treasurer's cash accounting is proper. The Audit Committee also compared the Treasurer's list of securities and investments with the Investment Custodian's list, and found them to be in agreement.

Respectfully submitted,
Peter K. Taylor, Rodney P. Plourde

Report of Awards Committee, 1980-1981

The committee reviewed applicable *Journal* articles and presentations made at the Society meetings for the purpose of establishing the annual Fitzgerald, Herschel and Technical Group Awards. The following award is recommended:

Geotechnical Group Award: William S. Zoino and Nicholas W. Campagna, Jr., "Engineering Behavior of the Taunton River Clays"

The committee also considered nominations for the Ralph W. Horne Award, for recognition of Section members who have been outstanding either in unpaid public service or municipal, state or federally elected or appointed posts or in philanthropic activities in the public service. The committee recommends Dr. Harl P. Aldrich, Jr. for the Horne Award on the basis of his commendable public service. Documents outlining Dr. Aldrich's accomplishments are on file in the Section office.

Respectfully submitted,
Charles A. Rosselli, Steven H. Corr, Joseph D. Guertin,
Dean K. White, William S. Zoino, Stanley C. Rossier
Peter K. Taylor, Chairman

Report of Thomas R. Camp Fund Committee, 1980-1981

The 1980-1981 Thomas R. Camp Lecture was held on March 11, 1981 at the Northeastern University Faculty Center. Dr. Richard I. Dick, Professor of Engineering at Cornell University, was the lecturer and the subject of his talk was "Sedimentation Since Camp."

The financial status of the Fund is set forth in the Report of the Treasurer.

Respectfully submitted,
Steven H. Corr, Chairman

Report of Continuing Education Committee, 1980-1981

The Continuing Education Committee presented a series of eleven lectures in the spring and the fall of 1980 to assist practicing engineers preparing for the state registration examination. Enrollment was approximately sixty. Questionnaires were distributed and evaluated on the effectiveness of the course and responses were incorporated into the program.

Respectfully submitted,
Ronald E. Sharpin, Chairman

Report of Employment Conditions Committee, 1980-1981

The Employment Conditions Committee was incorporated, this year, into the General Tasks Division, as outlined in the Operations Manual.

The Committee's membership for this year was as follows:
Kevin K. Egan, Chairman
James P. Troupes

The Committee was active in sponsoring a questionnaire jointly with Northeastern University and ASCE National's Supply and Demand Committee, a sub-committee of the ASCE Employment Conditions Committee. The questionnaire returns have been evaluated and produced some interesting results.

Unfortunately, the Committee was not able to publish the analysis this year, but the general membership can look forward to reviewing the results early next year.

The present Committee feels that significant progress in creating a more professional environment can only be achieved through a unified, organized and motivated society concerned for the continued advancement of the profession and material security for themselves and their families. The Committee would welcome additional members and support from all levels of the professional membership.

Respectfully submitted,
Kevin K. Egan, Chairman

Report of Ad Hoc Energy Committee, 1980-1981

The Committee co-sponsored three meetings during the fall of 1980 and the spring of 1981. These meetings were as follows:

1. Aquifer Thermal Energy Storage, co-sponsored with the Geotechnical Group and the New England Section of the Association of Engineering Geologists.

2. Current Transportation Strategies in Dealing with Energy Crises, co-sponsored with the Transportation Section.

3. Health and Safety Aspects of Conversion to Coal, co-sponsored with the Environmental Group.

In May a meeting will be co-sponsored with the Monthly Luncheon Series Committee.

A draft Energy Policy Statement was prepared and published in the November Newsletter for membership comment. A final copy of the statement, incorporating comments, will be prepared for approval by the Board of Government.

The Ad Hoc Committee is registered with the ASCE National's Energy Policy Committee and will act as liaison for the Energy Action Program.

Respectfully submitted,
A. Stanley Lucks, Chairman

Report of John R. Freeman Fund Committee, 1980-1981

The Freeman Fund Committee convened twice (at luncheon meetings at The Engineers Club) on June 9, 1980 and February 24, 1981.

A grant of $1,000 was made to M.I.T. in support of a group of Civil Engineering students who edited their term paper assessing the new Charles River Dam. The paper which is now ready for publication, may be included in a special issue of the *Journal* devoted to the basin improvements and to John R. Freeman's pioneering role in their achievement.

An excellent paper was submitted for consideration for the Freeman Hydraulics prize. The author chose to submit the paper elsewhere for publication after the Committee had returned it to him with questions and comments.

Requested support for the editing and republication of an old book was not granted because the Committee judged it fell outside the guidelines established in Freeman's letter of endowment to BSCE.

Approved expenditures from the Fund were $1,641.19, of which $1,000 went to M.I.T., as noted above, and $641.19 for the travel expenses of Professor John Paul Tullis when he came from Logan, Utah to address the Hydraulics Group's meeting on January 23, 1980.

The Committee encouraged the Student Affairs Committee to request Freeman Fund support for projects like the aforementioned paper by the M.I.T. students. It also agreed to give support if needed for the Small Hydro Lecture Series. That series was eminently successful, however, and made no call on the Fund.

The Committee agreed to subsidize a portion of the cost of student attendance at future lecture series.

Alarmed at the slippage in yield of the Freeman Fund in the past ten inflationary years, the Committee on March 2, 1981 asked the Section Treasurer to withdraw the Fund from the pooled investments of BSCES and reinvest them in shares of the Fidelity Equity-Income No-Load Fund.

Respectfully submitted,
THE JOHN R. FREEMAN FUND COMMITTEE
David R. Campbell, Harry L. Kinsel, Lawrence C. Neale, Donald R. F. Harleman
Lee Marc G. Wolman, Chairman

Report of History and Heritage Committee, 1980-1981

On March 19, 1981, the ASCE National Committee on the History and Heritage of American Civil Engineering acted favorably on our nomination of the Charles River Basin to be a National Historic Civil Engineering Landmark. The recommendation for designation will be submitted to the ASCE Board of Directors at its April meeting.

Various other subjects are in progress.

Mr. Potamis has completed research on the South Hadley Canal. Investigation is continuing on its possible qualification for national recognition. If it does not qualify we will submit it to BSCES for Massachusetts Historic Civil Engineering Landmark status.

Last year ASCE suggested that the early materials testing carried out at the Watertown Arsenal would qualify that site as a National Historic Civil Engineering Landmark. Mr. Battles is working on this project.

We were also asked by ASCE to determine if some important civil engineering developments, in addition to developments in mill production machinery, might have been responsible for the jump from small to large mills during the period around 1800. Mr. Cahill is working on this project.

Several projects are in process to inaugurate our program of Massachusetts Historic Civil Engineering Landmarks for the many significant sites that are of local rather than national significance. Offers of help from interested members would be welcome.

The Committee is in contact with the Museum of Transportation on the possibility of its new library becoming a repository for civil engineering plans and other material of historical importance.

Mr. Holly is again serving as a member of the ASCE National Committee on the History and Heritage of American Civil Engineering.

Richard Battles, Gary S. Brierley, Jim Cahill, Gerald C. Potamis
H. Hobart Holly, Chairman

Report of Investment Committee, 1980-1981

The Committee met in December 1980 with the Custodian of the Section's funds, Boston Safe Deposit and Trust Company, and at that time found its handling of the Section's holdings satisfactory.

Respectfully submitted,
Norman W. Bennett, Chairman

Report of Key Man Committee, 1980-1981

The Key Man Committee acts as a line of rapid communication between the Society and its members in local firms. Its primary purpose is to remind members of coming meetings or events of the Society.

At present there are 51 firms or institutions with key men tied into the committee and the effectiveness in boosting attendance at society functions appears to be satisfactory.

Respectfully submitted,
Frank J. Cullati, Chairman

Report of Lecture Series Committee, 1980-1981

The Lecture Series Committee met once during the year in session with the Program Committee to coordinate the schedule of the Lecture Series with Technical Group Meetings.

Lecture Series were held this year, as follows:

Group	*Dates*	*Sessions*	*Topic*
Hydraulic	Jan-Feb	7	Small Scale Hydro
Geotechnical	Mar-Apr	6	Groundwater Hydrology

These lecture series were very successful, well attended, and stimulated a great deal of interest within the society.

A Lecture Series Committee meeting in May is being planned. Attendance by key persons who planned this year's and past years' series, along with those who will be planning next year's series will assist in an evaluation and exchange of techniques. At this time one series is scheduled for 1981-1982; it will be in the Fall of 1981, by the Structural Group.

Respectfully submitted,
Stanley C. Rossier, Chairperson

Report of Membership Committee, 1980-1981

The Membership Committee consists of Richard M. Simon, George H. Bollier, Thomas R. Carabine, James V. Errico and Judith Nitsch Donnellan, Chairman.

The Committee's main goal in 1980-1981 was to enlist 50 new members in the Affiliate or Junior Affiliate categories. (Last year the Membership Committee received approval from the Board of Directors of the clarification of these membership qualifications to include technical professionals who may not be graduate engineers.) The Committee revised the BSCES Membership Application so it would apply to both regular and affiliate membership grades. Four hundred packets containing a cover letter, the new BSCES application, a dues notice and the "Why Join?" brochure were distributed through key BSCES members at civil engineering firms and agencies in Massachusetts to potential Affiliate and Junior Affiliate members. These packets were sent in December and we have received 13 applications. Five were referred to ASCE or BSCES regular membership status and eight applications have been approved or are pending. The project is being followed-up to ensure all the packets were distributed. We expect to have an increased number of applications with more publicity about these two membership grades.

We are also in the process of mailing ASCE membership applications, ASCE and BSCES brochures, and an invitation to join BSCES, to civil engineering seniors at ten area colleges. This mailing will be out by mid-April.

Sign-up sheets were used again this year at the Technical Group meetings to determine which attendees were not members so they could be contacted for membership. Because of the problem of non-members stating they were members in order to take advantage of the lower meeting prices, a Membership Card was included in the dues bills this year. These cards will be required at all meetings to determine membership status and the meeting prices to be paid.

As of mid-March, the Section has had 129 new member applications during the year in addition to the previously-mentioned Affiliate applications.

Respectfully submitted,
Judith Nitsch, Chairman

Report of Monthly Luncheon Series Committee, 1980-1981

This year the series of luncheon meetings was continued to provide a monthly function where the membership could meet and discuss timely professional topics.

The luncheon meetings were held at the Great Hall, Quincy Market. The meetings held were:

1. Thursday, October 16, 1980: Speaker, Peter J. Gianacakes, President, Metcalf & Eddy, Inc. Topic: Consulting Engineering in the 1980's: Changes, Challenges, Opportunities.

2. Thursday, November 13, 1980: Speaker, Secretary Joseph Fitzpatrick, Executive Office of Energy Resources. Topic: Current Transportation Strategies Dealing with the Energy Crisis.

3. Tuesday, December 9, 1980: Speaker, Joseph S. Ward, President, Converse, Ward, Davis, Dixon, Inc., and Past President, ASCE. Topic: Professional Societies, Are they Headed in the Right Direction.

There is one additional luncheon scheduled for May; and one luncheon had to be cancelled because of a scheduling conflict. If the luncheons monthly are to continue, it is suggested that one of the Technical Groups be assigned each month as co-sponsor.

Respectfully submitted,
Charles Calotta, Nicholas Mariani, Cranston Rogers
Brian Hogan, Chairman

Report of Nominating Committee, 1980-1981

The Committee met on October 31, November 21, December 12 and December 23, 1980. Members of the Committee were:

Charles C. Ladd, Chairman (Sr. Past President)
Howard Simpson, Vice Chairman (Past President)
Richard DiBuono, Clerk (elected 1979)
William S. Zoino (Past President)
Franklin B. Davis (elected 1979)
Warren H. Ringer (elected 1979)
Richard J. Scranton (elected 1980)
Paul A. Taurasi (elected 1980)
David E. Thompson (elected 1980)

The Committee recommends that the following members be endorsed by BSCES for consideration by ASCE National Professional Committees to represent Zone I. All nominees have completed the Professional Division Committee Nomination Forms.

Committee	*Nominee*
Professional Publications (CPP)	Domenic E. D'Eramo
Student Services (CSS)	No Nomination
Engineering Management Division Executive (EMDEX)	Dr. Robert D. Logcher

Member Activities Division Executive (MADEX)	Dr. Thomas K. Liu
Minority Programs (COMP)	(No Position Vacant)
Sections & District Councils (CS & DC)	Bertram Berger
Younger Members (CYM)	Denise Beaumont
Employment Conditions (COEC)	Maurice Freedman
Standards of Practice (COSP)	Francis X. Hall

The Committee recommends that BSCES endorse Ronald C. Hirschfeld as our nominee for District 2 Director and that our delegates to the District 2 Caucus to be held in March 1981 be so instructed. Regarding the position of Zone I Vice President, we recommend no endorsement by BSCES since it is our understanding that it is not District 2's "turn" according to the informal rotation arrangement; William H. Taylor of N.J. will most probably run and receive substantial support from other Districts of Zone I.

The Committee nominates the following for the BSCES Board of Government and Nominating Committee:

President:	Edward B. Kinner
Vice President (2 years term):	Richard J. Scranton
Secretary:	Rubin M. Zallen
Treasurer:	Richard F. Murdock
Directors (2 year term):	Judith N. Donnellan
	Warren H. Ringer
Nominating Committee (2 years term) (three to be elected)	Domenic E. D'Eramo
	Benjamin J. Fehan
	Richard A. Foley
	Rocco A. Mancini
	Saul Namyet
	Ronald E. Sharpin

Each of the above was contacted and agreed to be willing to serve.

The Committee also submitted the names of Albert G. H. Dietz and Murray B. McPherson to the Board of Government for election as Honorary Members of BSCES.

Confidential minutes were prepared for all meetings. The Clerk has been requested to transmit these to the incoming Chairman, Dr. Howard Simpson.

Respectfully submitted,
Charles C. Ladd, Chairman

Report of Operations Manual Committee, 1980-1981

The Committee prepared revisions to the Operations Manual required by actions of the Board of Government during the past year. Recommended changes and additions included:

1. Revisions to the Public Relations Committee functions including the establishment of a "Massachusetts Outstanding Civil Engineering Achievement Award".

2. Addition to the Manual of formal procedures for the Employment Conditions Committee.

3. Renaming the Disadvantaged Youth Committee as the Minority Affairs Committee and redefining its purpose to be consistent with a broader role.

The Committee's recommendations were approved by the Board of Government and the updated version of the Manual was distributed in January 1981.

Respectfully submitted,
Edward B. Kinner, Chairperson

Report of Program Committee, 1980-1981

The Program Committee met in early June to plan a schedule of Technical Group meetings and other activities for the year. In addition to Section and Technical Group meetings, the scheduling included lecture series, and monthly luncheon meetings. It was necessary to take into account holidays, school vacations, and meetings of other professional societies as well as known conventions. The planning included a total of 32 technical group meetings, two technical group field trips, two lecture series, six luncheon meetings and three energy committee meetings in joint session with technical groups. No attempt was made to schedule social functions at the time.

Technical Group meetings were generally held on Wednesdays, or on Tuesdays or Thursdays to avoid conflicts. Most of the meetings were scheduled in the evening after 5:30. Occasional noon-time meetings were tried. During the year a few conflicts developed and were handled on a case basis.

Respectfully submitted,
Stanley C. Rossier, Chairperson

Report of Public Relations Committee, 1980-1981

The committee this year was composed of the following members:

Robert J. Dunn, Jr.
Burt B. Jamison
Douglas F. Reed

Since the re-establishment of the Public Relations Committee in 1979 it members have worked diligently in efforts to bring about continued awareness of the accomplishments of both the BSCE Section and ASCE. In addition the Committee has responded to the responsibility of enhancing the image of civil engineers as a "People Serving Profession" through the distribution of information regarding the society, its programs, and its activities.

Though the efforts of the Committee are not always visible, its objectives and activities will become more evident in coming years to society members and the public through the establishment of a solid base of action.

In addition to activities already established, this year has seen the following activities initiated:

1. Selection of the first jury of judges for the 1st annual 1981 Massachusetts Outstanding Civil Engineering Achievement Award Competition since establishment in 1980. Members of the jury were as follows:

   Jury Chairman - Robert J. Dunn, Jr.
   Immediate Past Presidents - Howard Simpson
   Charles C. Ladd*
   At Large Members - Cranston R. Rogers
   Donald Harleman

   *Because of direct professional involvement with a possible nomination, immediate Past President William Zoino was not eligible to serve on the jury. This position was filled by the next past president, Dr. Ladd.

   The project submitted by SEA Consultants was recommended for an Award of Merit.

2. Lecture Series Coverage. The committee is actively pursuing publicity on lecture series sponsored by the BSCE Section technical groups through publication in the monthly publication of ASCE News. It is hoped that these brief news reports will create additional exposure and recognition to the BSCE Section.

The Public Relations Committee is an integral part of the society and its image. We encourage voluntary support of its activities by bringing items of interest to the attention of the Committee, and we welcome those interested in participating.

Respectfully submitted,
Robert J. Dunn, Jr., Chairman

Report of Publications Committee, 1980-1981

During the year, two issues of the BSCES Journal were published as Volume 67, Numbers 1 and 2. There continue to be about 2100 subscribers to the Journal, about 300 of them being from non-members, mostly libraries. A sincere word of thanks to Journal editor, Ed Keane, for his continued efforts to print the Journal in a timely and efficient manner. Ten issues of the monthly newsletter were published and thanks are given to Secretary Rubin Zallen and Executive Director Susan Albert for their efforts.

The Committee made a thorough review of the need, purpose and emphasis of the Journal during the year. The following principal items summarize the results of this effort:

1. The Journal will continue to be published.

2. In order to reduce costs and to provide suitable quality in each issue, the Journal printing will be reduced from four to two issues annually, commencing as soon as practicable.

3. Emphasis will be given to case studies, papers of practical application, and papers of local interest. Papers dealing with engineering issues and professional ethics will also be encouraged. As a matter of interest, the Committee intends to publish a minimum of four good quality papers of average length in each issue.

4. Restrictions on prior publication of papers submitted have been modified. Papers of significant historical interest or noteworthy technical papers may be republished in the Journal. To be considered historical, a paper in the computer field must be at least 15 years old and papers in other fields must be at least 25 years old. In order to be republished, a paper must receive written recommendation from the appropriate Technical Group Executive Committee and be approved by the Publications Committee.

5. The Executive Committee of each Technical Group is responsible for providing one acceptable paper in its field for publication in the Journal each calendar year.

6. The Advertising and Publications Committee will continue as separate groups with the appropriate Vice President being responsible for coordination.

The Committee's recommendation resulting from the study were approved by the Board of Government at its March meeting.

The Chairperson wishes to express his sincere thanks to Committee members who served actively in the Journal review process.

Respectfully submitted,
Glenn S. Orenstein, James C. O'Shaughnessy, Charles A. Rosselli,
Joseph D. Guertin, Dean K. White, James M. Becker,
Edmund J. Condon, Rubin M. Zallen, Edward C. Keane,
Edward B. Kinner, Chairperson

Report of Student Affairs Committee, 1980-1981

The Committee this year consisted of: Michael Kupferman, Chairperson, Steven L. Bernstein, Richard J. Scranton, Thomas Taddeo and Paul J. Trudeau.

Regular business included:

- liaison with ASCE Student Chapters
- solicitation of funds from area firms for student loans
- arranging for Contact Members for those schools in need of Contact Members

This year, in an effort to bring the entire BSCES community closer together, the Annual Student Night and the Annual BSCES Dinner Meeting will be a combined activity, to be held at the John F. Kennedy Library. During the evening the following presentations will be made:

Student Chapters with Outstanding 1979 Activities

1980 Robert Ridgway Award:	Northeastern University
1980 Certificates of Commendation:	Northeastern University
1980 Letter of Honorable Mention:	Merrimack College
	Southeastern Massachusetts University
	University of Massachusetts

ASCE Awards for Outstanding Service

S. Beeman (CM) SMU	M. Kupferman (FA) NU
W. Boyer (FA) UMass	F. Law (FA) SMU
R. Hassett (CM) UMass	R. Scranton (FA) NU
A. Hatheway (CM) NU	R. Snowber (CM) NU
M. Gaa (FA) Merrimack	L. Webster (CM) UMass

BSCES Awards

Desmond Fitzgerald Award ($200)	Ralph D. Nelson, Jr., Northeastern
William P. Morse Student Award ($200)	Patricia McCarry, Tufts
Howe-Walker Student Awards:	Paul R. Marcus, MIT Nora Daghlian, Merrimack Mark D. Evans, Northeastern Bruce T. Magley, Northeastern John F. Buckley, Jr., SE Mass. Gaye A. Cicalus, Tufts Wayne G. Gordon, Lowell Carolyn M. Gorczyca, UMass Kenneth F. Johnson II, Wentworth Susan Hoffma, WPI

The Student Affairs Committee continued the task of soliciting funds for the two interest-free student loans presented each year. Solicitations were made to over 600 area firms. Special thanks are extended to the following firms, whose generosity makes this endeavor possible:

Anderson-Nichols & Company, Inc.
Associated Engineers of Plymouth, Inc.
The Beacon Companies
Boston Survey Consultants
Camp, Dresser & McKee, Inc.
Crandall Dry Dock Engineers, Inc.
Thomas K. Dyer, Inc.
Fay, Spofford & Thorndike, Inc.
Gale Engineering Company, Inc.
Geotechnical Engineers, Inc.
Goldberg-Zoino & Associates, Inc.
Keyes Associates
Francis H. and Antoinette Ledgrad
Arthur D. Little Foundation
CE Maguire, Inc.
Chas. T. Main, Inc.
Maurice A. Reidy, Engineer
Kenneth and Irene Sherman
Skinner and Sherman Laboratories, Inc.
J.F. White Construction Co.
Abraham Woolf & Associates, Inc.
Zimpro, Inc.

The Student Affairs Committee also maintained contact with Student Chapters in Massachusetts throughout the year and made itself available to aid in their activities.

In 1981, the Student Affairs Committee intends to strengthen the ties between the Student Chapters and the engineering profession and will continue to promote efforts to this end.

Respectfully submitted,
Michael Kupferman, Chairperson

ANNUAL REPORTS OF TECHNICAL GROUPS

Report of Computer Group, 1980-1981

The Executive Committee this year consisted of the following:

John D. Goodrich	Chairman
Glenn S. Orenstein	Vice-Chairman
Mukti Das	Clerk
Ziad Ramadan	Member
Gonzalo Castro	Member
Robert A. Wells, Jr.	Member

Four regular meetings of the Computer Group were held as follows:

October 15, 1980 — Dinner meeting at MIT Faculty Club; "Fast Tracking with Structural Programming"; lecture by Prof. Jeffrey S. Lazarus of Boston University. Attendance, 19.

December 10, 1980 — Dinner meeting at MIT Faculty Club; "Fortran 77 - New ANSI Fortran"; lecture by Robert A. Wells, Jr. of Project Software and Development, Inc. Attendance, 38.

February 25, 1980 — Dinner meeting at MIT Faculty Club; "Software Used in a Modern Geotechnical Consultant's Office"; joint lecture by John D. Christian of Stone and Webster Engineering Corp. and Dr. Gonzalo Castro of Geotechnical Engineers, Inc. Attendance, 29.

April 8, 1981 — Joint meeting with the Structural Group at MIT Building 9, Room 9-150; "Interactive Design of Tents and Bubbles with Computer Graphics"; lecture by Dr. Robert Haber of the University of Illinois. Attendance, 31.

Officers and members of the Executive Committee for 1981-1982 will be as follows:

Glenn S. Orenstein	Chairman
Mukti Das	Vice-Chairman
Ziad Ramadan	Clerk
Gonzalo Castro	Member
Jack Horgan	Member
John D. Goodrich	Member

Respectfully submitted,
John D. Goodrich, Chairman

Report of Construction Group, 1980-1981

The Executive Committee this year consisted of the following members:

Chairman	Charles A. Rosselli
Vice Chairman	Donald W. Nickerson
Clerk	Mark Tedeski
Member	John R. Roma
Member	Stephen G. Walker
Member	John P. Sullivan

Meetings of the Construction Group held during the past year were as follows:

October 2, 1980 — Dinner meeting at MIT Faculty Club. Peter J. Philliou, Attorney at

Law, discussed the principles of liability with respect to responsible parties in construction and engineering. A printed summary of the topic (Who's At Fault) containing representative case studies was provided to all attending. Attendance, 36.

December 4, 1980 — Dinner meeting at Cottage Crest Restaurant, Waltham, Mass. Richard Reardon of the Army Corps of Engineers discussed various Army Corps projects past, present, and future, including the National Dam Safety Program. Attendance, 32.

March 26, 1981 — Dinner meeting at MIT Faculty Club. Anthony Barila, Asst. Manager, and John R. Roma, Project Engineer, both with Franki Foundation Company, discussed the construction and performance of the Ground Support System utilized at the Davis Square Station, MBTA.

May 28, 1981 — This will be a joint dinner meeting with the Geotechnical Group and the BSCE Section's Western Branch at the Marriott, Newton, Mass. Alan Hulshizer, project manager, United Engineers of Philadelphia, will discuss the Seabrook Tunnel project.

Officers and Executive Committee members for 1981-1982 are as follows:

Chairman	Donald W. Nickerson
Vice Chairman	Mark Tedeski
Clerk	Thomas Taddeo
Member	Charles A. Rosselli
Member	John R. Roma
Member	Stephen G. Walker

Respectfully submitted,
Charles A. Rosselli, Chairman

Report of Environmental Group, 1980-1981

The Executive Committee of the Environmental Group for 1980-1981 consisted of the following:

Chairman	Steven H. Corr
Vice Chairman	Gerald C. Potamis
Clerk	James C. O'Shaughnessy
Member, Executive Committee	Edward Boyajian
Member, Executive Committee	Richard K. Smith, Jr.
Member, Executive Committee	Stephen H. Geribo

The Environmental Group held the following meetings:

October 8, 1980 — Dinner meeting at Purcell's Restaurant, Boston. Michael O'Hare, Director, Office of Policy and Mangement Analysis, Department of Environmental Quality Engineering, spoke on "Hazardous Waste Disposal Siting." This was a joint meeting with the Society of Women Engineers. Attendance, 55.

January 21, 1981 — Dinner meeting at Purcell's Restaurant. Dr. Eliot Epstein, E&A Consultants, spoke on "Sludge Composting." Attendance, 32.

February 25, 1981 — Dinner meeting at Purcell's Restaurant. J.W. Lebourveau, New England Power Company, S. Burgess, Stone & Webster Corporation, A. Van Irsdale and K. Hagg, Department of Environmental Quality Engineering, spoke on "Environmental and Safety Aspects of Conversion to Coal by Electric Power Generation in New England." This was a joint meeting with the Ad Hoc Energy Committee. Attendance, 28.

March 11, 1981 — Dinner meeting at Northeastern Faculty Center. Dr. Richard I. Dick, Professor of Engineering at Cornell University, spoke on "Sedimentation Since Camp." This was the 1981 Thomas R. Camp Lecture and was co-sponsored by the Student Chapter ASCE of Northeastern University. Attendance, 65.

May 5, 1981 — The annual outing of the Environmental Group will be a tour of the MDC Prison Point Pumping Station and new Charles River Dam. James McCann, Resident Engineer, MDC Construction Division, and Edward Dunn, Vice President, CE Maguire, Engineers, will speak on the project at the dinner meeting following the tour. This meeting is also the annual election meeting of the Group. The following officers are proposed for 1981-1982:

Chairman	Gerald C. Potamis
Vice Chairman	James C. O'Shaughnessy
Clerk	Edward Boyajian
Member, Executive Committee	Richard K. Smith, Jr.
Member, Executive Committee	Stephen H. Geribo
Member, Executive Committee	Peter M. Smith

Respectfully submitted,
Steven H. Corr, Chairman

Report of Geotechnical Group, 1980-1981

The following were officers of the Geotechnical Group for 1980-1981:

Chairman	Joseph D. Guertin
Vice Chairman	Asaf Qazilbash
Clerk	James Weaver
Member, Executive Committee	Nuri Georges
Member, Executive Committee	Joseph Engels
Chairman, Forum Committee	Bruce E. Beverly

The Group held the following meetings this year:

September 9, 1980 — "Aquifer Thermal Energy Storage", a presentation by Mr. John R. Raymond, Staff Scientist, Battelle Pacific-Northwest Laboratories; at Kennecott Copper Corporation, Lexington. This was a joint dinner meeting with the Ad Hoc Energy Committee and the Association of Engineering Geologists. Attendance, 74.

October 7, 1980 — Dinner meeting at Tufts University. "Ground Freezing", a presentation by Mr. Derek Maishmann, Freezewall, Inc., at Tufts University. Arranged by the Geotechnical Forum Committee of the Group. Attendance, 48.

November 12, 1980 — Dinner meeting at Engineers Club, Boston. Panel Discussion, "Sewers in Poor Soil Conditions; Improving Practice in the 80's". Joint presentation by Francis T. Bergin, Chief Engineer, MDC Construction Division; William S. Zoino, Principal, Goldberg, Zoino & Associates, Inc.; and Denis M. Foley, J.F. White Contracting Company. Attendance, 110.

January 13, 1981 — Dinner meeting at Northeastern University. "Cellular Cofferdam for Trident Submarine Drydock, Naval Submarine Base, Bangor, Washington", a joint presentation by Max D. Sorota, Principal, Fay, Spofford & Thorndike, Inc. and Dr. Edward B. Kinner, Principal, Haley & Aldrich, Inc. Attendance, 86.

February 11, 1981 — Dinner at Averof Restaurant; meeting at Masonic Temple, Cambridge. "Geotechnical Design and Construction of the MBTA Porter Square Station", a joint presentation by David E. Thompson, Haley & Aldrich, Inc. and Edward Plotkin, MacLean Grove & Company. Arranged by the Geotechnical Forum Committee of the Group. Attendance, 79.

May 28, 1981 — This is planned as a dinner meeting at Howard Johnson Restaurant, Newton. "Seabrook Nuclear Power Facility Tunnels", presented by Mr. Allen Hulshizer, United Engineers and Constructors, Philadelphia, PA. Joint meeting with the Section's Construction Group and the Western Massachusetts Branch BSCES/ASCE.

Geotechnical Lecture Series

A lecture series arranged by the Geotechnical Group, entitled "Groundwater Hydrology" began on March 10, 1981. Attendance was 500. The chairman for the lecture series was Mr. Peter Riordan. The subjects and lecturers were:

March 10, 1981 — "Analytical Methods in Groundwater Hydrology", by Professor John Wilson, III of MIT.

March 18, 1981 — "Groundwater Resource Evaluation", by Mr. William Walton of Camp, Dresser & McKee.

March 25, 1981 — "Effects of Groundwater on Planning, Design and Construction", by Dr. Ralph Peck Consulting Engineer.

March 31, 1981 — "Groundwater Contamination, Part A: Mass Transport", by Dr. George Pinder, of Princeton University.

April 7, 1981 — "Groundwater Contamination, Part B: Chemistry and Field Sampling", by Dr. John Cherry, of the University of Waterloo.

April 14, 1981 — "Groundwater Law and Regulations", by Dr. Jay Lehr of the National Water Well Association.

Officers and Executive Committee members for 1981-1982 are as follows:

Chairman Asaf Qazilbash	Member, Executive Committee Nuri Georges
Vice Chairman Lew Edgers	Member, Executive Committee Joseph Engels
Clerk James Weaver	Member, Executive Committee Richard Simon

Respectfully submitted,
James W. Weaver, Clerk

Report of Hydraulics Group, 1980-1981

Chairman	Dean K. White
Vice Chairman	Paul F. Shiers
Clerk	Varoujan Hagopian
Member	David A. Spieler
Member	Richard J. DiBuono
Member	Edward P. Dunn

The meetings held by the Hydraulics Group are summarized below:

October 22, 1980 — Evening meeting at Ralph M. Parsons Water Resources Laboratory at MIT. "Solar Energy and Heat Pumps in the Swedish State Power Board R & D Program." Dr. Peter Larsen, Director, The Swedish State Power Board Hydraulic Laboratory. Dr. Larsen presented an overview of the Board's solar energy program with particular emphasis on storage of solar energy. Attendance, 22.

November 22, 1980 — Meeting at Lawrence Experiment Station, Lawrence, Mass. Mr. Donald R. Burns, Project Manager, Allis-Chalmers Corporation, discussed the design and construction of the two bulb turbine units being installed at the Great Stone Dam. The talk was followed by a tour of the job site which is part of the works owned by the Lawrence Hydroelectric Associates. Attendance, 36.

December 17, 1980 — Evening meeting at Ralph M. Parsons Water Resources Laboratory at MIT. "Combined Use of Physical and Mathematical Modeling in Evaluating Effects of Pumped Storage Operation on a Reservoir." Speakers: Dr. Dominique N. Brocard, Lead Research Engineer, Alden Research Laboratory, Holden, Mass., and Dr. E. Eric Adams, Principal Research Engineer, Energy Laboratory, MIT. The presentation centered around the use of physical and mathematical models to determine the potential environmental effects of a proposed pumped storage project on a reservoir. Attendance, 10.

February 25, 1981 — Evening meeting at Ralph M. Parsons Water Resources Laboratory at MIT. "Storm Water Management - Quantity and Quality; A Case Study in Planning and Design." Mr. Edward B. Boiteau, Engineer, Sasaki Associates, Inc. Mr. Boiteau discussed, with the use of two case studies, storm water management for new development in urban areas. Attendance, 21.

April 15, 1981 — Dinner meeting Ell Student Center, Northeastern University. "Hydraulic Transients: Noises in the Night." Dr. Paul H. Rothe, Senior Engineer, Creare Inc., presented a survey of problems, technologies and solution for situations involving fluid transients and flow oscillations driven by rapid steam condensation, fluid machinery, piping system components, or two phase flow. Attendance, 21.

May 20, 1981 — This will be an evening meeting, at Ralph M. Parsons Water Resources Laboratory at MIT. "Current Status of the Non-Federal Dam Inspection program". Mr. E.P. Gould, Program Manager, New England Division, U.S. Army Corps of Engineers, will present the results to date from inspection of over 1,000 non-Federal dams in New England.

Hydraulic Group Lecture Series

A lecture series arranged by the Hydraulics Group on Small Scale Hydro Power began on January 6, 1981. The chairman for the lecture series was Paul F. Shiers of Stone and Webster Engineering Corporation. Attendance was 148. The subjects and lecturers were:

January 6, 1981 — "Hydrologic Analysis for Power Potential." Philip Manley, Chief, Hydrologic Engineering Section, New England Division, U.S. Army Corps of Engineers.

January 13, 1981 — "Economic and Financial Analysis." Gordon A. Marker, President, Essex Development Associates, Inc.

January 20, 1981 — "Hydroelectric Equipment Selection." Warner W. Wayne, Jr., Consulting Engineer, Stone and Webster Engineering Corp.

January 27, 1981 — "Power System Integration." Robert O. Bigelow, Vice President and Director of Planning and Power Supply, New England Electric System.

January 27, 1981 — "Federal and State Licensing Process." Prof. Peter W. Brown, Director, Energy Law Institute, Franklin Pierce Law Center.

February 3, 1981 — "Physical Layout and Hydraulic Design." Mircea S. Vasilescu, Consulting Engineer.

February 10, 1981 — "Small Scale Hydro: Case Studies." Mr. Eugene O'Brien, Partner, Tippetts Abbett McCarthy Stratton.

Moderator for the Lecture Series Program: Prof. Henry M. Paynter, Department of Mechanical Engineering, MIT.

Hydraulics Group Officers for 1981-1982 were elected at the April meeting. The Executive Committee for the coming year will be as follows:

Chairman	Varoujan Hagopian
Vice Chairman	Paul F. Shiers
Clerk	David A. Spieler
Member	Richard J. DiBuono
Member	Edward P. Dunn
Member	Dean K. White

Respectfully submitted,
Dean K. White, Chairman

Report of Structural Group, 1980-1981

The Executive Committee this year consisted of the following members:

Chairman	James M. Becker
Vice Chairman	Kenneth B. Wiesner
Clerk	Maurice A. Reidy
Member-at-Large	Thomas Tsotsi
Member-at-Large	Emile Troupe
Student Member	Jay Minkoff, Tufts University
Immediate Past Chairman	Richard A. Foley

The meetings held by the Structural Group were as follows:

October 1, 1980 — Professor Stanley T. Rolfe, University of Kansas, presented the AISC T.R. Higgins Lectureship Award paper entitled "Fracture and Fatigue Control in Steel

Structures". Professor Rolfe's lecture was oriented toward the practicing engineer's concerns with controlling fracture and fatigue in various types of steel structures. The lecture covered basic problems associated with fracture and fatigue control related to materials, design, fabrication and loading. Examples were given of structural failures in buildings and bridges. General design approaches were discussed with respect to both fracture and fatigue. The value of steels with better notch toughness and their use in fatigue and fracture control were also covered. In summary, Professor Rolfe pointed out that one needs to have control of design, materials specifications, fabrication and loading in order to avoid problems associated with fatigue and fracture. The evening meeting was held at the Center for Advanced Engineering Studies at MIT. Attendance, 110.

December 3, 1980 — Brice Bender, P.E., BVN/STS Consulting Engineers, Indianapolis, Indiana, presented a talk on the design and construction of the Zilwaukee Bridge near Saginaw, Michigan. Mr. Bender discussed the design and construction of this major precast, segmental bridge, and a comparison with the design approach used for the Kentucky River Bridge in Frankfurt, Kentucky. The Zilwaukee Bridge is under construction and, at 8,000 feet in total length, will be one of the world's largest concrete bridges. The evening meeting was held at Barnum Hall, Tufts University. Attendance, 70.

February 4, 1981 — Messrs. Peter Nelson and Werner Gumpertz of Simpson, Gumpertz & Heger, Consulting Engineers, Cambridge, Massachusetts, presented a joint lecture on waterproofing of roofs and below-grade structures. Peter Nelson spoke first, on below-grade waterproofing. His talk was illustrated with many slides of the "dos" and "don'ts" of waterproofing. Werner Gumpertz's talk dealt with roof construction. His talk was also amply illustrated with slides. These presentations included practical advice on the state of the art in waterproofing materials and methods and case study examples of waterproofing problems and their solutions. This evening meeting was held at the Ell Student Center, Northeastern University. Attendance, approximately 120.

April 1, 1981 — Patrick Dunn, Manager of Civil Engineering, Shell Oil Company, Houston, Texas, presented a talk entitled "COGNAC: World's Tallest Off-shore Oil Platform". Mr. Dunn described the design, fabrication, and installation of COGNAC, the world's tallest off-shore platform, which received the Outstanding Civil Engineering Achievement Award for 1980 from the American Society of Civil Engineers. It is a 59,000-ton structure, taller than the Empire State Building. This evening meeting was held at the MIT Center for Advanced Engineering Studies. Attendance, 75.

April 8, 1981 — Prof. Robert Haber, University of Illinois, spoke on "Interactive Design of Tents and Bubbles with Computer Graphics". This meeting was held jointly with the Computer Group of the BSCE Section. The Structural Group was co-sponsor in order to highlight the importance of computers as engineering tools. This evening meeting was held at the Center for Advanced Engineering Studies at MIT. Attendance, 31.

At the April meeting, elections were held for the Executive Committee for year 1981-1982. This year the Committee decided to increase the number of members-at-large from two to three. The Executive Committee membership for 1981-1982 will include:

Chairman	Kenneth B. Wiesner
Vice Chairman	Maurice A. Reidy
Clerk	Thomas Tsotsi
Member-at-Large	Emile Troupe
Member-at-Large	Morris S. Levy
Member-at-Large	Nicholas Mariani
Student Member	To be Decided, from MIT
Immediate Past Chairman	James M. Becker

In addition to running this year's series of meetings, the Structural Group has been working on a lecture series for the fall of 1981, tentatively titled "Structural Design of Building Cladding".

October 13, 1981	*Introduction to Cladding Dsign* Leslie Robertson, Skilling, Held, Christenson and Robinson, New York
October 20, 1981	*Cladding Design for Wind* Alan Dalgliesh, Division of Building Research, National Research Council, Ottawa, Canada
October 27, 1981	*Design of Glazing Systems for Building Cladding* Robert McKinley, PPG Industries
November 3, 1981	*Design of Metal Curtain Walls* Philip Bonzon, Director of Research, Development and Design, Cupples Products, St. Louis, Missouri
November 10, 1981	*Design of Masonry Cladding* Jerry Stockbridge, Wiss, Janney, Elstner and Associates, Northbrook, Illinois
November 17, 1981	*Design of Precast Concrete Cladding* Speaker to be Announced
December 1, 1981	*Cladding Problems: Prevention, Analysis and Cure* Speaker to be Announced

The Committee intends to publish proceedings of the series.

Repectfully submitted,
James M. Becker, Chairman

Report of Transportation Group, 1980-1981

The Executive Committee this year consisted of the following members:

Chairman	Edmund Condon
Vice Chairman	Robert A. Snowber
Clerk	Thomas F. Humphrey
Member	Paul Levy
Member	Robert Tierney
Member	Frank McCarran
Member, Past Chairman	Rocco Mancini
Representative to JRTC	Marvin W. Miller

The following meetings were held during the past year:

May 12, 1980 — National Transportation Week Seminar. Co-sponsored with the Boston Transportation Group and other transportation oriented organizations. Lester P. Lamm, Executive Director of the Federal Highway Administration was the luncheon speaker and spoke on new Federal transportation policy directions. During the morning a panel discussion took place on the topic of "Transportation Strategies of the 1980s." The seminar panelists included: Moderator, Dean Daniel J. White, Boston College Graduate School of Arts and Sciences; participants, Donald W. Carpenter, President and Chief Executive Officer, St. Johnsbury Trucking Co., Inc.; Alan G. Dustin, President and Chief Executive Officer, Boston and Maine Corporation; Barry M. Locke, Secretary, Massachusetts Executive Office of Transportation and Construction; and Daniel Roos, Director, Center for Transportation Studies, Massachusetts Institute of Technology. The meeting was a morning and luncheon program at Pier 4 Restaurant. The attendance was 400.

September 25, 1980 — The consultant selection process used by several Massachusetts public agencies was discussed by a panel consisting of Justin L. Radlo, Massachusetts Department of Public Works; Richard Dempsey, Massachusetts Bay Transportation Authority; Martin Weiss, Metropolitan District Commission; and David Weiner, Massachusetts Port Authority. Each panel member briefly reviewed his agency's procedure for consultant selection, and a commentary was delivered by a representative of the consulting profession. A very interesting question and answer period followed. This was an evening session held at Nick's Restaurant. Attendance, 120.

November 13, 1980 — Seminar, "Current Strategies for Dealing with An Energy Crisis." The speaker was Joseph Fitzpatrick, Secretary, Massachusetts Executive Office of Energy Resources. The Secretary presented the current status of energy problems and alternative solutions from both a local and national perspective. He emphasized transportation issues in particular, and described some of the emergency measures being considered by Massachusetts. This was a luncheon meeting held at Polcari's Restaurant. Attendance, 70.

January 23, 1981 — "Major Development Projects in Boston." The speaker was Robert Ryan, Director of the Boston Redevelopment Authority. He presented a brief overview of development projects underway and planned within the City of Boston, with slides of projects underway. This was a luncheon meeting held at Polcari's Restaurant. Attendance, 92.

March 19, 1981 — "Massachusetts Transportation Problems and Programs" presented by Barry Locke, Secretary of Transportation. This was the annual meeting of the Transportation Group. Secretary Locke reviewed current programs and described problems anticipated in the state. He also discussed the possible impacts of new Federal directions. Attendance, 62.

Elections were held and the following were elected for 1981-1982.

Chairman	Robert Snowber
Vice Chairman	Paul Levy
Clerk	Frank McCarran
Member	Robert Tierney
Member	Frank Sholock
Member	Guy Denizard
Member, Past Chairman	Edmund Condon
Representative to JRTC	Marvin Miller

This was the Group's annual meeting, held at The Sultan's Tent Restaurant. Attendance, 62.

Six meetings of the Executive Committee were held, April 1980 through March 1981.

Respectfully submitted,
Thomas F. Humphrey, Clerk

ANNUAL REPORT OF THE WESTERN MASS. BRANCH

Introduction

During the past year, an effort has been made by the Western Massachusetts Branch (WMB) to increase the level of activity by its membership. We are facilitating this goal by direct contact to area engineering firms and industries, increased coordination with the activities of the Boston Society of Civil Engineering Section (BSCES), and a broader offering of activities of interest to our members. These programs will be discussed later.

Traditionally, the WMB has been strongly centered around the engineering community of the University of Massachusetts (UMass). This is reflected by our meeting schedule and the interest of the UMass Student Chapter in our functions. Although we don't want to weaken our valuable ties with UMass, we also need to be more responsive to the needs of members residing and working throughout the Pioneer Valley and possibly Berkshire County. It is hoped that our new activities will begin to serve this need.

In addition to reaching more members, it is also important to motivate these members into an active level of participation. At present, all of the organizational work for activities is being performed by WMB officers, with a few notable exceptions. At some point it becomes impossible for a few individuals to devote enough time to accomplish the tasks required of increased activity levels. Hopefully, the new programs will achieve this need too.

1980-1981 Officers

The officers elected in May 1980 for the current year are as follows. As an initial step in accomplishing the goal of active participation, we are increasing the governing body of the WMB to include past-presidents as part of an executive committee. Although this is outlined in the BSCES Operations Manual, it has not been practiced in the past. The result of this was the effective loss of knowledgeable WMB leaders from WMB organizations.

President	Dr. John Collura Department of Civil Engineering University of Massachusetts Amherst, Massachusetts 01003
Vice-President	Walter Schwarz Gordon E. Ainsworth & Associates, Inc. 20 Sugarloaf Street South Deerfield, Massachusetts 01373
Treasurer	Lawrence Smith Gordon E. Ainsworth & Associates, Inc. 20 Sugarloaf Street South Deerfield, Massachusetts 01373
Secretary	William Hover Goldberg, Zoino and Associates 450 Memorial Drive Chicopee, Massachusetts 01020
Newsletter Editor	Karen McElroy Tighe and Bond/SCI 50 Payson Avenue Easthampton, Massachusetts 01027

Activities

The basic format of WMB activities is a series of dinner meetings. As indicated above, they are somewhat tailored to the UMass schedule and are held 5 to 6 times from September through May. This system will be replaced next year by a more-structured bi-monthly series of meetings. The meetings typically consist of a cocktail hour and dinner at a popular local restaurant, followed by a short business meeting and a speaker or presentation to our members.

Meetings held this year are as follows:

September 9, 1980 — At Lord Jeffrey Inn, Amherst. Speaker, Richard Hassett P.E., Arabian Bechtel. Topic, Construction at Jubail City, Saudi Arabia. Attendance: 41

October 14, 1980 — Joint meeting with Connecticut Section at Sheraton Tobacco Valley, Windsor, Connecticut. Topic, Tour of Combustion Engineering Facility. Attendance: 100

March 11, 1980 — Joint meeting with UMass Student Chapter at Top of the Campus, Amherst. Speaker, Robert Vanesse, P.E., Vanesse-Hansen and Associates. Topic, Starting a Consulting Firm. Attendance, 41 members, 60 students

Additional dinner meetings scheduled for the remainder of this year:

April 28, 1981 — At Roadway Inn, Chicopee. Speaker, Michael Jones, P.E., MMWEC. Topic, Tour of new gas fired power plant; discussion, "Energy Outlook for the 80's".

May 28, 1981 — Joint meeting with BSCES Geotechnical/Construction Groups at Howard Johnson's, Newton. Speaker, Allen Hulshizer, United Engineers. Topic, Seabrook Tunnels.

June — Date, topic, and location to be established

In addition to our dinner meetings, we are also involved in other activities. We have sponsored a successful continuing education course at UMass for the past several years. This years course will be held during the fall semester. Organizational work is well under way and the topic will most likely involve aspects of project management or the use of small computers in civil engineering applications.

A hazardous waste lecture series has been developed and will held on the four Tuesday evenings in May. The information for the series is given in the Appendix to this report.

Two other major activities are scheduled for the near future. The format for our newsletter has been developed as have the basic arrangements for publication. Personnel commitments have delayed publication to this point but should be progressing shortly. The newsletter, combined with a newly acquired bulk mailing permit, will allow us to communicate better with our increased membership at a substantial cost saving. Finally, details for a jointly sponsored two-day workshop entitled "Mass Transportation and Downtown Revitalization" are being completed. The workshop will be held at Mt. Holyoke College in mid-June. Details will be announced shortly.

Financial Report

The following financial report documents income and expenditures for the period beginning September 1, 1980 and ending March 31, 1981. Because of our rapidly changing method of operations and activities, no budget has been finalized for the year. A copy of the proposed budget as well as last years information is provided in the Appendix.

Date	*Item*	*Income*	*Expense*
9/1/80	Previous Balance	$ 365.78	
9/8/80	Summer Mailouts		$157.35
9/9/80	September Dinner Meeting		$ 43.10
10/23/80	October Mailout		$ 21.00
1/6/81	ASCE Management Conference		$ 15.00
1/20/81	Officers Expenses		$ 39.20
1/20/81	Officers Expenses		$ 36.57
2/9/81	BSCES Allotment	$1,000.00	
2/11/81	Meeting Room Deposit		$ 50.00
2/11/81	Officers Expenses		$ 17.50
2/27/81	March Mailout		$ 36.00
3/9/81	Past President Award		$ 33.00
3/11/81	March Meeting		$ 78.00
3/12/81	Officers Expenses		$ 59.86
3/30/81	April Mailout		$ 51.48
4/2/81	Past President Award		$ 40.45
	Account Interest	$ 7.84	
Totals to Date		$1,373.62	$678.51
Balance		$ 695.11	

As indicated, our greatest expenditures include printing and mailing, student meeting subsidies (half cost), and officers expenses, primarily travel. Potential revenue generating activities in the near future include the lecture series, workshop, and the continuing education course.

APPENDIX I

1981 lecture series on HAZARDOUS WASTE DISPOSAL

Western Massachusetts Branch, BSCES/ASCE

Course Outline

1. May 5, 1981	GOVERNMENT PROGRAMS AND FUNDING	John Hackler
	LEGAL ASPECTS OF HAZARDOUS WASTE DISPOSAL	Anton Moehrke
	REGULATORY AGENCIES	Stephen F. Joyce

2. May 12, 1981	PROBLEM DEFINITION AND CONCEPTUAL SOLUTIONS - CASE HISTORIES	Dr. Larry Feldman
3. May 19, 1981	ENGINEERING SOLUTIONS-MIGRATION AND CONTAINMENT	Michael Powers
	ENGINEERING SOLUTIONS-TREATMENT	Phil Virgadamo
4. May 26, 1981	HAZARDOUS WASTE SITE SELECTION AND EVALUATION (NEW SITES)	Dr. Ray Holmes Dr. Bruce Hunter

APPENDIX II

Western Massachusetts Branch, BSCES/ASCE

PROPOSED BUDGET

1980-1981

ITEM	BUDGETED 1979-1980	ACTUAL 1979-1980	BUDGETED 1980-1981
Speakers Meals	$ 70.00	$ 52.50	$ 70.00
Speakers Expenses	50.00	15.00	50.00
ASCE Student Meal Subsidy	200.00	242.50	300.00
Student Chapter Support	25.00	60.00	50.00
Postage and Printing	110.00	124.15	400.00
Workshop	150.00	0.00	150.00
Lecture Series	0.00	0.00	150.00
President Pins	9.00	10.00	10.00
Officers Expenses	70.00	87.71	100.00
Continuing Ed	0.00	0.00	0.00
		TOTAL	$1,280.00

CURRENT HOLDINGS	371.82
APPROPRIATION REQUEST	1,000.00

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