

Prof. Bengt Baltzar Broms

Bengt Baltzar Broms was born in Örebro, Sweden on 17 June 1928. He obtained his C.E. degree in 1952 from Chalmers Institute of Technology, Gothenburg, Sweden, continuing postgraduate studies at the University of Illinois, Urbana, toward M.S. and Ph.D. degrees in 1954 and 1956, respectively.

From 1956 to 1959, Dr. Broms was employed as a Research Engineer in the Shell Development Company in Houston. In 1959, he joined Cornell University, Ithaca, New York as Associate Professor. He returned to Sweden in 1964 to take up the position of Director General of the Swedish Geotechnical Institute (SGI), Stockholm. From 1974 to 1982, he was Professor of Soil and Rock Mechanics at the Royal Institute of Technology (KTH), Stockholm. He joined Nanyang Technological University in Singapore in 1983, where he was Professor and Head of the Division of Geotechnics and Surveying until his retirement at the end of 1995.

Prof. Broms has actively served the international geotechnical community in numerous capacities, including Vice-President for Europe (1977-81) and President (1985-89) of the International Society of Soil Mechanics and Foundation Engineering (ISSMFE).

Prof. Broms is member of the Swedish Academy of Engineering Sciences, Honorary Member of the Swedish Geotechnical Society, and Honorary Professor at Tongji University, Shanghai. He has received many awards in Sweden and abroad for his scientific achievements.

During his studies at Chalmers Institute of Technology, Gothenburg (M.Sc.) and at the University of Illinois (M.Sc. and Ph.D.), Prof. Broms was a brilliant student and graduated with highest grades. Thereafter, he worked as research engineer on offshore projects for Shell in Houston, Texas where he performed groundbreaking work on laterally loaded piles. Thereafter, he embarked on an academic career on three different continents (Cornell, USA; KTH, Stockholm, Sweden and NTU, Singapore) where he was advisor to, and mentor of, numerous students.

From 1964 through 1974, he was director of the Swedish Geotechnical Institute (SGI), where he assembled a group of young engineers from different parts of the world, encouraged them to develop new ideas and supported their research.

With a brilliant yet humble personality, Prof. Broms was able to create an inspiring working atmosphere, generously supporting and encouraging his collaborators and students. He was an excellent educator and outstanding lecturer, known for his free-hand drawn diagrams. As an academic supervisor, he was demanding yet generous with his time and support.

Prof. Broms' theoretical and practical work covers many areas of soil mechanics and geotechnical engineering. He is the author and co-author of more than 400 scientific papers, book chapters and books.

He pioneered research regarding the design of laterally loaded piles, the effect of negative skin friction on pile foundations, ground movements caused by pile driving and the application of stress-wave measurements for pile design. He initiated the first two conferences on stress wave theory of piles, held in Sweden in 1980 and 1984, respectively.

He studied the effect of compaction on lateral earth pressure, the application of vibratory compaction methods, improvement of soft clays by lime columns, geotextile-reinforced earth and in-situ methods to analyse and monitor slopes and embankments on soft and sensitive clays.

Recognizing the importance of field investigations and the need of harmonization of penetration testing methods and equipment, he initiated the first European Symposium on Penetration Testing (ESOPT), held in Stockholm in 1974. He also made important contributions to the design and application of different ground improvement methods such as lime-cement columns and vibratory compaction of soils.

Prof. Broms vitalized geotechnical activities while at the Nanyang Technological University (NTU), teaching numerous students and initiating geotechnical research and development in the region. At NTU, he organized a series of international geotechnical seminars and symposia, attracting eminent geotechnical engineers from different parts of the world. The Bengt B. Broms Symposium on Geotechnical Engineering was held in Singapore in 1995 in recognition of his outstanding contributions and achievements.

In his native country Sweden, Prof. Broms was president of the Swedish Geotechnical Society (SGF) and awarded honorary society membership. As head of the Royal Commission on Pile Research, he was responsible for the implementation of many pile research projects, which have been documented in numerous publications; Prof. Broms also initiated the creation of the Swedish ground vibration commission and a research group working on with soil and rock dynamics at the Royal Institute of Technology (KTH).



Prof. Bengt B. Broms

Dr. Karl Rainer Massarsch was employed as a young engineer at the Swedish Geotechnical Institute in 1970 and later performed his doctoral studies under Prof. Broms at the Royal Institute of Technology (KTH) in Stockholm. Throughout his career, he has been inspired and guided by Prof. Broms, especially directing him towards research in the area of soil dynamics. He became the first professor in soil and rock dynamics at KTH and chaired during 4 years ISSMGE TC 10, Geophysical Testing. He was chairman of the Swedish Committee on Ground Vibrations and Chairman of two European Standardisation Committees (CEN/TC 288), which prepared standards on Deep Soil Mixing (WG 10) and Vertical Drainage (WG 11).

During June 2009, it was my privilege to meet with Prof. Broms at his residence to chat about his life and achievements. It was challenging to get Prof. Broms to speak about his personal life as he preferred to address technical matters. At the time of the interview, he was still active as an advisor to doctoral students and engaged in some consulting activities. Throughout his life he was supported by his wife, Carina who followed her husband around the globe.

Professor Prof. Bengt Baltzar Broms

Reminiscences

Interviewer: Interviewer: K. Rainer Massarsch, former student of Prof. Broms
Location: Residence of Prof. Broms in Stockholm, Sweden.

Bengt Baltzar Broms was born in Örebro, Sweden on 17 June 1928. He obtained his C.E. degree in 1952 from Chalmers Institute of Technology, Gothenburg, Sweden, continuing postgraduate studies at the University of Illinois, Urbana, toward M.S. and Ph.D. degrees in 1954 and 1956, respectively.

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Prof. Broms' research includes cracking in reinforced concrete members, lateral resistance and buckling of piles, lateral earth pressure due to compaction, vibratory compaction, lime columns, negative skin friction, concrete piles, geotextile-reinforced earth, penetration testing, landslides and soil improvement methods. He is the author and co-author of more than 400 papers, book chapters and books.

Prof. Broms is member of the Swedish Academy of Engineering Sciences, Honorary Member of the Swedish Geotechnical Society, Commander of Nordstjärneorden and Honorary Professor at Tongji University, Shanghai. He has received many awards in Sweden and abroad for his scientific achievements.

KRM: Thank you Bengt for sharing this afternoon with me. You are on your way to your summer house in Dalarna (a province in central Sweden close to the border with Norway). I know that you have invited many visitors to your summer house - sometimes they were encouraged to help with repairing the house and painting walls, I have been told!

BBB: Yes, we have had many visitors to Stockholm and most of them enjoyed seeing the Swedish countryside. This is a place where I was able to get away from a sometimes rather hectic schedule.

KRM: I understand that your father also was an engineer - did this influence your choice of profession?

BBB: I was the only child and my father was proud that I was interested in engineering. I took my civil engineering degree at Chalmers University of Technology in Gothenburg. Already as a student, I was interested in geotechnical engineering. Prof. Sven Hultin, one of the originators of the Swedish Slip Circle method, was one of the teachers that influenced me.

KRM: I understand that shortly after receiving your C.E. Masters degree at Chalmers, you went to North America?

BBB: Yes indeed, and it was the late Prof. Sven Olov Asplund who suggested me to go to the USA. This was a difficult decision, as I had just met my future wife, Carina. We had little money to start with and only high school knowledge of English. I started working in a small engineering firm in Cincinnati where I became involved in the design of a very large and challenging project - the Ohio Turnpike. We worked on average 10 to 12 hours a day, six days a week.

KRM: And then you applied to the University of Illinois in Champaign, Urbana for masters and thereafter doctoral studies?

BBB: I was granted a research assistantship in the Department of Theoretical and Applied Mechanics. The topic of my PhD thesis was Ultimate Strength of Long Reinforced Concrete Columns, which I did under the supervision of Dr Ivan Viest.

KRM: How did you become interested in geotechnical engineering?

BBB: Well, I attended lectures given by Prof. Ralph Peck. It was fascinating to hear him speak on various engineering projects and the importance of geotechnical aspects. So, most of my course choices were in geotechnical engineering. I also had the opportunity to listen to Prof. Karl Terzaghi, who came occasionally to give lectures. I had much to learn and felt very privileged.

KRM: I understand that there were a number of students at the University of Illinois who later became quite famous.

BBB: Indeed, the late Fazlur Kahn who became one of the leading structural engineers was a close friend. And there was Louis Menard, who did part of his work on the pressuremeter while he was in Urbana, working with Prof. Peck. Prof. M. A. Sozen, now at MIT was also a friend.

KRM: Following your Ph D, you joined Shell Development Company in Houston?

BBB: Yes, I was asked to build up a geotechnical laboratory and to participate in the design of the then deepest oil offshore facility - 40 m, which was a record depth. And the design was state of the art, with a bottle-shaped structure to minimize brunt of hurricane waves. One of the challenges was to determine the lateral resistance of piles during wave loading.

KRM: You have told stories about pile load tests in the Louisiana swamps, with alligators watching you at close distance?

Reminiscences (continued)

BBB: At that time, Shell embarked on a large-scale lateral pile load test program. We were going in a small boat and, once, a very big alligator was stopping us; about 7 - 8 m long and obviously interested in geotechnical problems. It was not very encouraging to go on shore and to do the tests. Prof. Lymon Reese and Prof. Hudson Matlock worked on the same project, but mainly on deformation behavior. I studied the ultimate capacity of laterally loaded piles. The work was reviewed by Karl Terzaghi; to work with him was a unique experience.

KRM: *This investigation resulted in one of your well-known papers on the lateral resistance of piles. After working for Shell, you went to Cornell University.*

BBB: In 1959, Prof. George Winter asked whether I was interested to come to Cornell University and I felt this would be a challenging task. I stayed about five years and enjoyed teaching and research work.

KRM: *And then you moved back to Sweden and became Director General of the Swedish Geotechnical Institute in Stockholm!*

BBB: There was a vacancy at SGI after its director, Justus Osterman, had suddenly passed away. And I was offered to succeed him. So, we moved back to Sweden, with four children born in the US. I did not then know much about Swedish geotechnical engineering and had to brush up on the Swedish practice of applying soil mechanics.

KRM: *How do you see your time at SGI in hindsight?*

BBB: At the beginning, I had to get accustomed with many new things, the way of life and the type of work is quite different here, compared to North America. Initially, my main goal was to build a strong team, to hire bright young engineers in Sweden and abroad - you Rainer, and Bengt Fellenius were among a group of outstanding people at SGI. Also the contributions of Nils Flodin, head of the well-known SGI Library were of great importance for the geotechnical community in Sweden but also abroad. I am very proud that SGI became an international gathering place with visitors from many countries. Listing all visitors would be too long and I would still forget a few names.

KRM: *For many foreigners, the conferences arranged in Sweden are well known - can you tell a little about them?*

BBB: I agree, this is an interesting question. When I became chairman of the ISSMFE Technical Committee on Penetration Testing, together with the late Prof. de Beer time was ripe to summarize the state of the art in Europe and therefore we arranged a European Symposium on Penetration Testing, ESOPT in 1974. I persuaded you to becoming secretary general. Later, ESOPT became global - ISOPT, and a series of conferences on penetration testing and site characterization have been held since.

KRM: *One of your main interests has always been piling technology, and especially driven piles? You were very active in the Swedish Commission on Pile Research.*

BBB: This Pile Commission is a unique association of the Swedish piling industry with a close cooperation between all; consultants, contractors, researchers, and government. The full-scale tests on negative skin friction, conducted by Prof. Bengt H. Fellenius, have shed light on the settlement mechanism and gave a fundamental understanding of the problem. We also had close cooperation with many experts from different countries, for instance with Prof. George Goble on dynamic pile testing he visited Sweden several times. Also the first Stress Wave Conference were held in Stockholm in June 1980 and the second again in Stockholm in 1984. These conferences have had great importance on the acceptance of dynamic pile testing.

At SGI, we were also very interested in ground improvement methods, and especially methods of stabilizing soft clay - which poses major foundation problems in the Nordic countries. For example, the cardboard drain, invented by the first director of SGI, Walter Kjellman, the plastic drain, invented by Oleg Wager, and the lime column method, invented by Kjeld Paus. These methods have since spread around the world and not many people know that the ideas originated in Sweden.

KRM: *The research results in the test field in Skå Edeby - a difficult name to pronounce for foreigners - have played an important role, hasn't it?*

BBB: Yes, many new techniques were tested at this site. Stockholm needed a new airport and one of the potential locations was Skå Edeby, with very difficult soil conditions. In 1946, Terzaghi was invited to visit Sweden to study the field conditions at Skå Edeby - he was picked up at Logan airport in Boston by the Swedish Royal Air Force and was the only passenger on the plane. He recommended a series of test embankments, which became the beginning of the, now, national geotechnical test site. When the site was abandoned as location for the airport, the SGI could continue to pursue field studies at the site. For example, in around 1955, driven sand drains installed and tested by Prof. Sven Hansbo, who later became the first professor of geotechnical engineering in Sweden. Terzaghi was also involved in starting a field test in Mällösa, an airport location thought suitable as an alternative at the time. Twenty-five years later, Dr. Y.C. Chang used the tests results for a part of his Ph.D. work, carried out under the supervision of Prof. Peck.

KRM: *In 1974, you became professor in soil and rock mechanics at the Royal Institute of Technology (KTH), shortly before SGI was moved from Stockholm? Quite an honor, considering that this was the department at which Wolmar Fellenius as Professor!*

Reminiscences (continued)

BBB: Indeed - and I was entrusted to build up a new department, covering soil and rock mechanics, and later soil dynamics. The number of researchers and doctoral students increased and we were able to maintain close contacts with the international geotechnical community, in spite of the move of SGI from Stockholm. I am also very proud of the work done by many doctoral students at KTH.

KRM: *During this period you were also very active in ISSMFE.*

BBB: From 1977 until 1981, I served as Vice President of ISSMFE for Europe, with the 10th International Conference being held in Stockholm at the end of my term. One of the persons most strongly working for bringing the conference to Sweden was Prof. Hansbo, then president of the Swedish Geotechnical Society. The Swedish King opened the conference. Also, this was the first conference to introduce the idea of “home hospitality”, inviting conference participants as guests to members of the host country. This concept, which has now become a tradition, and many other aspects of the conference were quite successful.

KRM: *And in 1985 you became president of ISSMFE.*

BBB: I was elected in 1985 at the San Francisco conference, and this was quite an honor for a small country. At that time, I had already moved from Stockholm to Singapore, where I was given the task of starting up a geotechnical department at the newly founded Nanyang Technological Institute, NTI, which later became Nanyang Technological University, NTU. This was a remarkable period not only in Singapore but in the entire region, with many interesting construction projects just starting up.

KRM: *Also there you continued arranging geotechnical seminars and conferences, which attracted many participants from the region and abroad. During your career you consulted on many major construction projects.*

BBB: I was fortunate to become involved in several very interesting projects. In Singapore, work on the MRT subway had just started, so I had the opportunity to get involved in some aspects of this complex project. One of my more spectacular project involvements was serving as consultant on the foundation of the Kuwait towers.



Conference in Singapore in honor of Prof. Bengt Broms, 1995

KRM: *Your lectures about the collapse of the New World Hotel are quite well-known!*

BBB: I was member of the panel that was charged with the investigation of the failure of this hotel in Singapore, which collapsed on March 15, 1986. The story about the design and construction of the hotel sounds like a saga. Only one of three owners could write and read. The piles were driven without knowing the shape of the building. The original structural engineer had also made a serious error in calculating the weight of the building. At the time of the collapse, the six-storey hotel was quite busy, so nobody paid attention when they heard cracking in walls and columns. During a seven-day rescue operation after the collapse, 17 people were found alive, but 33 people lost their lives. As a consequence of the failure, the government of Singapore introduced tighter regulations on building construction.

KRM: *Returning to your presidency of ISSMFE, I understand that you had several concerns about the future of the society?*

BBB: Yes, at that time, the question of the name of the society was discussed and disputed. It was suggested by some to include the term “geotechnical engineering” - which since has been implemented. Another of my concerns was the low number of young

Reminiscences (continued)

participants at international conferences. With the support of several others, such as the late Prof. Niels Krebs Ovesen of Denmark, the first Young Geotechnical Engineers Conference was organized. Prof. Robert Holtz, guest researcher at the SGI 1971-1973, assisted in the idea of creating “geotechnical model libraries” for newly established universities, especially in developing countries, to be donated by the society and sponsors. Also individual members were encouraged to contribute. With the evolution of information technology, this idea can now probably be implemented more easily.

KRM: You are the author of several books and many publications. The reader easily recognizes your papers by your hand-drawn figures. You are famous for your personal style!

BBB: I always enjoyed drawing figures by hand. Unfortunately, now I cannot draw any more, my right hand is too shaky.

KRM: Time is passing quickly, so I would like to ask you a final question - which are the most important challenges for the engineering profession and our society in particular?

BBB: Well, no doubt, environmental problems are highest on the list. We need to take care of all waste and - if possible - make use of it. Geotechnical and environmental engineering must be going hand in hand and can offer many effective solutions. Another important question is storage of nuclear waste, also here geotechnical engineering plays an important role.

KRM: Bengt, I do not want to keep you any longer from going to your summer house. Thank you very much for your time!

BBB: It was my pleasure, Rainer!



Dr. K. Rainer Massarsch and Prof. Bengt B. Broms during the interview in Stockholm.



Prof. Bengt Broms and wife Carina during the interview.