

BHOJ RAJ SETH

(1907—1979)

Elected Fellow : 1961

BIRTH AND EARLY INFLUENCES

BHOJ RAJ SETH was born on August 27, 1907 at Bhura, Punjab in a sturdy Punjabi Khattri family which believed in high ideals of service to the community. Bhoj Raj himself proved to be a great parsonification of these ideals. He was the eldest of a family of four members and he delayed his own marriage till his two brothers were well educated with his support and his sister was married in a good family. He had however the satisfaction of seeing both of his brothers doing way well. Balraj Seth did his PhD in Economics and became very early Director of Industries in Delhi. Govind Ram Seth did his PhD in Statistics and rose to be the Director of the Indian Agricultural Statistics Research Institute and later occupied many important positions in various international agencies. Bhoj Raj Seth continued to show the same spirit of consideration and sacrifice which he showed for his brothers and sister for every one of hundreds of his younger colleagues and students and thus left his mark not only as a great applied mathematician of modern times, but also as a good and generous person.

EDUCATION AND DOCTORAL RESEARCH

Seth received his degree and post-graduate education at Hindu College Delhi from where he obtained the BA (Hons) and MA degrees of Delhi University in 1927 and 1929 respectively. He obtained first Division and first position in both the examinations. He was awarded gold medals by the university for his brilliant performance in both the examinations.

As a result of his extra-ordinary performance at the MA examination, he was awarded the Central Government Scholarship for higher studies in England. Though in India, Seth had the good fortune of being taught by some very good teachers, they were all brilliant problem-solvers, but no one was a research scholar. In fact mathematics research was almost unknown in Delhi at that time. However the creative mind of Seth was at once fascinated in England by the work of such eminent applied mathematicians as Lamb, Love, Filon, Pearson, Taylor and others. This influence is clearly visible in his earlier work on potential problems and plasticity.





In London, Seth took courses in elasticity, photo-elasticity, fluid mechanics and relativity and was awarded the MSc degree of London University in 1932. In 1933, he attended courses at the university in Berlin. In 1934 he was awarded the PhD degree of the university of London for his thesis on *Finite Strain in Elastic Problems*, written under the supervision of Professor LNG Filon. The quality of his thesis can be judged from the fact that a major part of it was published in the *Transactions of the Royal Society* and became the starting point of many subsequent investigations on Saint-Venant's problems of torsion and flexure. Here he gave a second order treatment of simple torsion, pure flexure and torsion based on quasi-linear stress-strain relation. Contributions to Saint-Venant problem of torsion and flexure were made by many eminent researchers like Elderton, Pearson, Timoshenko and Young, all of whom had however considered only the symmetrical case. In 1934, Seth gave the first complete solution for a right-angled isosceles triangle. In appreciation of his work on this problem, Professor Stevenson wrote: *No account of work on Saint-Venant's problem will be complete which did not pay tribute to the work of Seth.*

Seth also gave complete solution for an eccentric hollow shaft. He also considered the problems of liquid contained in rotating cylinders with triangular section. When his first paper on the problem appeared in 1934 in the *Oxford Quart Journal*, the editor of the journal suggested himself that he should extend his methods to the region exterior to the cylinder which Seth did successfully. This work was published in 1935 in the same journal. Subsequently Seth gave a comprehensive solution of such potential problems both for exterior and interior domains.

In Fluid Mechanics, Seth showed that standing transverse waves in a canal of closed section were not possible and that Lamb's solution for a canal of circular section needed modification, as the approximate mode assumed was unstable. Another important contribution he made was to show that slow viscous solution could be obtained by superposition of two effects—one due to irrotational flow for the same boundary and another due to a concentrated force in an infinite liquid, the drag suffered by the body, being equal to the concentrated force.

Besides his contributions to Fluid Mechanics and Elasticity, Seth also collaborated with Professor Harris in his experimental work on photo-elastic properties of celluloid.

In 1937, Seth obtained the Doctor of Science degree of the university of London. Before that he spent a year at the university of Perugia in Italy.

The research work leading to his DSc degree shows remarkable originality and creativity. The same originality continued to be the hall-mark of his research on his return in India in 1937.



HIS LATER CONTRIBUTIONS TO KNOWLEDGE

On his return, Seth devoted himself to problems of bending, vibration and stability of membranes and plates with triangular boundaries and to the application of finite strain theory to these problems. One of the most important contributions of Seth during the sixties was to the determination, among other things, of the stage at which the constitutive equations change form. For this purpose Seth introduced the concept of transition. He showed that the transition concept does away with the necessity of introduction of semi-empirical relations like yield conditions, jump conditions etc. He also showed that all transition fields like boundary layers, shocks, elastic-plastic deformations, creep and fatigue are subharmonic or superharmonic in character and that vorticity and spin effects play an important role in their growth.

Seth's asymptotic treatment of the finite torsion problem provides one of the few examples in which a plastic state resulting from large deformation is predicted by elastic theory.

In 1964, Seth suggested the generalised strain measure given by

$$\int_{L_0}^L \left(\frac{L_0}{L} \right)^{n+1} \frac{dL}{L_0} = \frac{1}{n} \left(1 - \left(\frac{L_0}{L} \right)^n \right),$$

where the weighting function is $(L_0/L)^n$, n being a material constant, L_0 is the natural length and L is the extended length. Seth pointed out that a continuum approach necessarily means the introduction of non-linear measures' and that classical measures of deformation are totally inadequate to deal with the transitions involving irreversible processes such as elastic plastic transition, creep, relaxation, fatigue and shocks. If in a very small interval, the number of changes occurring in a material is very large, the ordinary measure based on Riemann integral concept fails and measures like that of Lebesgue have to be used. In like manner general measures given by weighted integral representations give very satisfactory result in problems of elasticity and plasticity. Based on his ideas, several research workers developed the strain measures and verified them experimentally.

Seth made outstanding contributions to Elasticity, Plasticity, Boundary Layer Theory, Potential Theory and a number of allied disciplines. His work is referred to in many standard books including mathematical theory of elasticity by Sokolinokoff and elasticity and plasticity by Goodier and Hodge. His most outstanding contributions were to Saint Venant's Problem, Potential Flows for Exterior and Interior Domains, Distributions of Generalised Singular Points, Systematic theory of Transition and Non-Linear Measures of Deformation.



ORGANISATIONAL ABILITY AND INSPIRING LEADERSHIP

After his return from England in 1937, Seth was appointed as the Head of the Department of Mathematics at Hindu College Delhi and also concurrently as a reader in Mathematics at the university of Delhi. He held those positions with great distinction for about twelve years and established great traditions of scholarship and research in Delhi University at that time. It was at his initiative that a research scholarship was established in his college as early as 1941. A number of students whom he taught and inspired at Hindu College became later Fellows of the Indian National Science Academy.

Early in 1949, he went to Iowa State University (Ames, Iowa) as a visiting Professor for a period of two years. Immediately on his return, he was called upon to provide leadership to the department of applied mathematics at the newly-created Indian Institute of Technology at Kharagpur. During the next sixteen years which he spent at Kharagpur, he built up a strong school of research in Elasticity, Plasticity, Rheology, Fluid Dynamics and Numerical Analysis. His hard work and organisational ability paid rich dividends. The department of Mathematics at IIT, Kharagpur came to be known as one of the foremost centres of research in these areas, not only in India, but all over the world. The youngmen trained here formed the main strength of the departments of mathematics of many regional colleges of engineering and other IIT's which started later.

Apart from building up the Mathematics Department, Seth played a great role in building up those traditions which have made IIT's as those institutions of national learning of which everyone can be proud.

Great farsightedness and vision was again shown by Seth when in 1955, he founded the Indian Society of Theoretical and Applied Mechanics (ISTAM). He nurtured this young plant for about twenty-five years and made it into a strong tree. This society provided a common platform for engineers, applied mathematicians, statisticians and computer scientists to discuss problems of common interest in a real interdisciplinary atmosphere. In all conferences of the Society, Seth was a dominant figure, making insightful remarks on almost every paper. Hundreds of young research scholars received great encouragement and inspiration from him at these conferences.

In 1966, Seth was called upon to assume the office of the vice-chancellor of the then newly started Dibrugarh University, in which capacity he served till 1971. He fought all influences aiming to dilute standards and appointed persons of merit to all posts inspite of great pressures. In 1971 after successfully completing his term, he was invited to take over as Director of the Birla Institute of Technology at Mesra, Ranchi, from which post he retired in 1977. He again rejuvenated that institution and worked for its autonomous status.



From 1977 till his death on December 12, 1979, Seth worked as Professor Emeritus at IIT, Delhi and concurrently at Delhi University.

Throughout these forty-two years, Seth displayed great dedication to high academic ideals, great humanism and unusual qualities of inspiring leadership. He guided more than two dozen doctoral students and a remarkable feature of his research guidance work is that he does not have joint papers with his students. This is a far cry from a situation in which in some cases almost every paper of a PhD student carries the name of the supervisor as a coauthor irrespective of the degree of contribution by the supervisor. Seth stood for the highest possible professional standards.

VISITING PROFESSORSHIPS AND INTERNATIONAL CONFERENCES

Seth worked as a visiting professor at three American institutions: at Iowa State University, Ames, Iowa, (1949-50); at Mathematics Research Centre, University of Wisconsin, Madison (1961-62) and at Oregon State University, USA (1967-68).

Seth attended six international congresses of mathematicians at Harvard, USA (1950), at Amsterdam, Netherlands (1954), at Stockholm, Sweden (1968), at Nice, France (1970), at Vancouver, Canada (1974) and at Helsinki, Finland (1978).

He attended four international congresses on theoretical and applied mechanics the seventh congress at London (1948), the eleventh congress at Montreal (1964), the thirteenth congress at Moscow (1972) and the fourteenth congress at Delft (1976).

He also attended seven international symposia organised by International Union of Theoretical and Applied Mechanics—on Boundary Layers at Freiberg (1957), on Non homogeneities in Elasticity and Plasticity at Warsaw (1958), on Elastic Plastic Shells at Delft (1959), on Secondary Effects at Haifa (1961) on Continuum Mechanics at Tbilisi (1963) and on Creep at Gothenberg (1976).

He also attended three international congresses on Rheology in West Germany (1958), in France (1972) and Sweden (1976).

He was also an active-participant in the Fifth Commonwealth Educational Conference held at Canberra, Australia (1971).

Seth was invited four times (in 1957, 1958, 1961 and 1970) by the USSR Academy of Sciences to give lectures. He was also invited five times by the Polish Academy of Sciences (in 1957, 1958, 1961, 1970 and 1972) for the same purpose.

In USA, he gave lectures at the universities of Wisconsin, Rhode Island, Carnegie-Mellon, Wayne State, Brown, Minnesota; Idaho State, Oregon State, Colorado, Houston, New Orleans, Iowa State, Cornell, North Carolina, Columbia, Rutgers, Massachusetts, Rochester, Yale, Virginia, State and Cal Tech.



In Canada he gave lectures at universities of Toronto, Calgary Saskatchewan, Alberta and at the institute of Aerospace Studies.

Seth was a most widely travelled mathematician. He visited more than two dozen countries and wherever he went, he visited universities, gave lectures and held discussions with mathematicians, scientists and engineers.

He visited Australia (1971), Austria (1954, 1961, 1962), Belgium (1957, 1970), Canada (1967, 1974), Czechoslovakia (1966, 1972), Denmark (1967), Egypt (1954, 1966), Finland (1978), France (1933, 1937, 1961, 1970, 1972), Hungary (1975), Hongkong (1960), Iran (1976), Israel (1957, 1958, 1961), Italy (1937, 1954, 1961, 1962, 1970, 1972, 1975), Japan (1960, 1968), Lebanon (1959, 1970), Netherlands (1954, 1959), Pakistan (1957), Poland (1957, 1958, 1961, 1970, 1972, 1975), Roumania (1969), Sweden (1962, 1970), Switzerland (1954, 1961, 1962), Thailand (1960, 1968), Turkey (1969), UK (1930-34; 1937, 1948, 1949, 1961, 1962, 1976), USA (1949-1950, 1960, 1961, 1967, 1974). USSR (1950, 1958, 1961, 1963, 1970, 1972, 1978) and West Germany (1932, 1954, 1957, 1959, 1962, 1964, 1972, 1974).

FELLOWSHIPS, AWARDS, HONOURS AND DISTINCTIONS

Seth was Fellow of the Indian National Science Academy, the Indian Academy of Sciences, the Delhi School of Economics and of the Institute for Social and Economic Change, Bangalore. He was also the first Indian to be elected as a fellow of the Polish Academy of Theoretical and Applied Mechanics.

He was president of Indian Society of Theoretical and Applied Mechanics, (1964-66), Mathematics Section of Indian Science Congress (1955), Mathematical Association of India (1969-79) and of Calcutta Mathematical Society.

The Indian Institute of Technology at Kharagpur, to whose development he contributed immensely, conferred on him in 1968 the degree of Doctor of Sciences (*Honoris Causa*). The USSR Academy of Sciences awarded him the Euler Medal in 1957 in recognition of his contributions to Continuum Mechanics. In March 1978, he was honoured by the coveted Dr BC Ray National Award for Eminent Men of Science for the year 1977. He is the only mathematician so far to have received this award.

ACADEMIC ACTIVITIES IN INDIA

Though Seth was very active at the international level, his role was no less dynamic in Indian academic institutions. He was the heart and soul of the Indian Society of Theoretical and Applied Mechanics and he has left his indelible mark on four institutions viz. Hindu College, Delhi; Indian Institute of Technology, Kharagpur; Dibrugarh University and Birla Institute of Technology at Mesra. His impact on other IIT's and many regional colleges of engineering has been significant.



He also played an active role in the Indian Science Congress, Calcutta Mathematical Society, Indian Mathematical Society, Bharat Ganit Parishad and the Mathematical Association of India.

Seth also gave extension lectures at the university of Lucknow (1939) on Two Dimensional Boundary Value Problem, at Osmania University on Finite Deformations (1954) and on Transition theory of Elastic Plastic Deformations (1964) and at Jadavpur University (1965) on Some Problems in Fluid Mechanics.

Seth participated actively in most of the national conferences on Mathematics Education. He also contributed indirectly by encouraging his younger colleagues all over the country to work for improvement of mathematics education. However he believed that the best method for improving educational standards was to inspire both students and teachers and to infuse them with high ideals of excellence.

Though Seth was an applied mathematicians and established a great school of applied mathematics, he was ready to give all encouragement to pure mathematics. However he was a great believer in interaction between mathematicians, scientists and engineers and did everything possible to encourage this interaction. He was totally opposed to mathematics being isolated from the main stream of Science and Technology.

HIS PERSONAL QUALITIES

Seth never criticized anybody personally and he never encouraged others to criticize third parties in their absence. He had no doubt differences with others on matters of policy and he would fearlessly and openly discuss these differences, but there was never a trace of personal bitterness in these discussions. Even when somebody told him that he was being criticized by some persons, he would simply smile and say, *Perhaps they are misinformed or misguided.*

He was highly patriotic and was quick to retort if anybody Indian or foreign, dared to criticize his country. He always emphasised the strong points of our culture and traditions.

Once a visiting professor who was invited to act as an adviser in a selection committee began criticizing the presence of outside experts in our selection committees. Seth politely told him *This constitution of the selection committee is according to an act passed by our Parliament. How will you like if I come to your country and begin criticizing acts passed by your Congress, not that I cannot do it. You are here to advise about the suitability of the candidates. Please remember that you are here to advise, not to decide. The decision will be taken by the members of the selection committee.* On another occasion an American visitor began criticizing the untouchability practices in India. Seth told him *Those who live in glass houses should not throw stones at*



others. First you do full justice to your blacks. We have to be jointly up in arms against all discrimination practices.

He was life of every party he attended and his stock of humour, wit and anecdotes appeared inexhaustible.

He never overawed anybody, nor he allowed anybody else, however big, to overawe him. His relations with both his seniors and juniors were governed by considerations of mutual respect.

He fought for rights of his students and younger colleagues. He saw to it that they did their best and then they got what they deserved. He inspired respect not by the power he held but by his personality, his great ideals and his love and consideration for others.

On one occasion when the university head of department of Delhi expressed his unwillingness to allot a postgraduate course to a young but brilliant lecturer, Seth offered to withdraw from postgraduate teaching in his favour. In another case he refused to set a university paper unless younger colleagues were given papers to set. His attitude was quite in contrast to that of others who in some sense 'exploit' their students and colleagues by keeping all remunerative jobs for themselves, by insisting on their names being on all research papers written in their laboratories and even being main guides to research scholars when the real guides are in fact their younger colleagues.

He was active till the last. He had a heart attack and was admitted to hospital, but continued in his normal jovial mood and he was declared recovered when a second heart attack came again and took away from us a great man and a great mathematician.

Seth was fearless fighter for the cause of teachers. At Hindu college, he was always in the forefront of the struggle when either the principal or the management wanted to take biased disciplinary action against a teacher. His methods were always clean. He would go and argue the case of the teacher with the authorities and convince them that the action was not justified. He would not mind rebuking the teacher if he was wrong. On account of his academic standing; his ideals and his fearlessness, he commanded so much respect with late Sri Ram who was the chairman of the Board of Governors of Hindu College, that almost all matters were resolved amicably.

Seth was one of the main persons responsible for the formation of the Delhi University Teachers Association. When Sir Maurice Gwyer, the then Vice-chancellor expressed his mis-giving about the formation of this association, Seth went straight to him and tried his best to convince him that the Association was in the best interest of the university. Sir Maurice Gwyer did not agree, but this reduced the tension that was building up.



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JN KAPUR

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