

Life Story Of A Structural
Engineer
By



U. H. VARYANI

The Book

Recounts the experiences of the author in the field of structural engineering during his professional career of 45 years. Starting from a humble background, he graduated in civil engineering in 1958 from the Indian Institute of Technology (IIT), Kharagpur and worked in India and abroad with many reputed firms of architects and government departments. He recounts many interesting incidents of design of various types of buildings handled by him and also gives a brief glimpse of his literary activities which culminated in the writing of four books and forty papers. This book has seven chapters and gives an insight into a period of 45 years of the author's professional life. It would be of interest to the entire engineering community.

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Yoga is skill in action

(Gita 2:50)

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U. H. VARYANI, Consulting Structural Engineer (Retd.)

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Preface

On the suggestion of a friend, I have ventured to write out my life story as a structural engineer. It has a span of forty five years. I have spent my entire professional life in the field of structural design of buildings in association with architects. It has been a hectic life. I am an engineer of the middle order. I spent over a year in Germany and ten years in Libya. I have written four books and forty papers. I have designed about 2000 buildings, big and small, with the help of my design staff. Along with design of structures, writing on structural engineering has been my passion. Many young engineers have worked with me during my professional career and we have learnt and benefited from one another.

My life story is quite ordinary. If there is anything extraordinary in it, it is for the readers to find out. I wish them a good reading.

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U. H. VARYANI

Chapter 1

Early Life And Education

I was born on 3rd July 1936 in the village of Nasarpur, Tehsil Tando Alhyarkhan, District Hyderabad in Sindh (now in Pakistan). I come from a lower middle class family. My father died early. My eldest brother took care of the family. I completed my primary education in Tando Alhyarkhan. In 1947, our family shifted to Ajmer, Rajasthan and there I completed my matriculation in 1952. I did my intermediate in 1954 from P. R. College, Kakinada, Andhra Pradesh.

I got admission in Kakinada Engineering College and also in the Indian Institute of Technology (IIT), Kharagpur in 1954. My second eldest brother who was settled in Kakinada suggested that I should study engineering at Kakinada as this would be economically convenient for the family. But I insisted on joining IIT Kharagpur as it was the only IIT in the country at that time and it was a residential institute under the Central government. As for financial constraints I was confident of getting a scholarship to avoid placing any additional burden on the family.

A few weeks after I joined IIT Kharagpur, scholarship examination was conducted. Though I was only an intermediate, many others were B.Sc., some with first class, from different universities. I was naturally nervous but by God's grace I was successful in getting a merit-cum-means scholarship of Rs.50 a month. This gave me great happiness and made me self-confident. An additional scholarship of Rs.50 a month was granted by the A.P. Government by way of

Refugee Scholarship. Thus I managed my education on these scholarships for all the four years of my stay at IIT, Kharagpur. The A.P. government scholarship's money of Rs.600 per annum used to come at the end of an academic year so there used to be some anxious moments due to financial hardship during the course of a year. My friends used to take care of me and bail me out every time. Oh, such wonderful friends I had then! The student age is an age of sacrifice. There was no thought in the mind then of withholding anything from friends and one always went out to help each other. That was a wonderful period of life.

IIT was a wonderful institute. Each student had his own room. It was convenient for intensive study. Library had a rich collection of technical books. We were also taught subjects like literature, civics, philosophy, economics, history, geography, etc. The institute provided a healthy environment for learning. In mathematics, physics and chemistry, we had both closed-book and open-book examinations. In

open-book examination, students were allowed to take along textbooks, class notes, etc in the examination hall and it was a great challenge to answer the examination paper in the allotted time of three hours. It was rare to obtain 100% marks in the open-book examinations; 50-70% score was considered exceptionally good. There used to be three terms a year. (Session system was not in vogue then.) All the terminal examinations were equally important for clearing the year. Each term had different subjects as well. The course material covered used to be quite large in each subject. Faculty was excellent. We used to work hard. Home assignments had to be completed in time. These also carried marks. Drawings had to be completed in time. They had to be neat and tidy.

Hostel life was interesting and busy. Mess food was good and it was of an all-Indian character. Students hailed from all parts of the country and all different food tastes were to be catered for. Evenings were reserved for games. One of the subjects included was social

service or N.C.C. I was in the N.C.C. for a couple of years and attended their residential camps at Agra and Secunderabad. Those were also my memorable experiences.

Among academic subjects, I got interested in structural design of steel and reinforced concrete structures. The reason for this may be that structural design is based on mathematics and strength of materials and it is not descriptive. I had a sort of horror of descriptive subjects in which we had to remember a lot. In reinforced concrete, we had a good and dynamic young Professor S.K. Mallick who gave us a good grounding in the subject. He was very fast in teaching and we had to exert a lot to keep pace with him. We used to stand in awe of him. We were afraid to get our doubts clarified during the course of his lectures, as he used to get annoyed when interrupted. So many of us were not able to follow his lectures. Only a few, including me,

could somewhat understand his lectures. My notes were written so fast that I myself was often unable to decipher them. After the class Professor Mallick was quite accessible and friendly too.

Four years passed away fast and after the fourth year final examination, we spent two months extra at the institute to complete our project, which in my case, was a road project that included a small reinforced concrete bridge also. Then most of the students left for their homes. I and a few other students were staying in the hostel to prepare for UPSC examination to get into some prestigious government department. During this time, I landed a design engineer's job in a private architectural firm at Chandigarh through a newspaper advertisement. The initial salary was Rs.375 a month which was supposed to be quite good at that time and much more than what one would get in a government job. I wanted to join the

firm after the UPSC examination. But the company management was insistent on my joining them without delay. So I left for Chandigarh, without going to my home town Kakinada.

Chapter 2

First Ten Years Of My Professional Life (1958-68)

I joined the office of M/s. Chowdhury and Gulzar Singh, Architects and Engineers, at Sector 8A, Chandigarh on 21.7.1958. Chandigarh is a beautiful, clean city. It was a pleasure to work there. My first design job was Empty Bag Storage Building of the Nangal Fertilizers and Chemicals Factory, Naya Nangal. The building was earlier designed by one of my colleagues, who was then leaving the firm. The design was to be revised for a new value of live load, the earlier value being unacceptable to the clients. This proved to be an

easy task. I had to just follow the steps already given in the design with the new value of live load. This gave me an insight into the procedure followed in the office and soon I completed the new design and the previous drawings were modified and sent to the site for execution. At this stage, it may be noted that this sort of job is ideal for a novice. A new engineer generally finds himself lost in office. The college procedures are not adequate for a professional design office. Senior colleagues and the head of department should look after new engineers for their prompt and proper grooming. Later I used to give new engineers, already completed designs of buildings to study, understand and tell them that this would be their first job. This way new engineers can acclimatise themselves with the procedures followed in a design office.

Mr. Gulzar Singh was an excellent structural engineer, with clear and incisive mind. He was an excellent human being too. I was lucky to have got the opportunity of working with him at the initial period of my

professional career. In the office, we had a good team of structural draftsmen too. For the success of a structural engineer, a good structural draftsman is essential.

In the office, we were about half a dozen young structural engineers with three structural draftsmen. Mr. Gulzar Singh was the Structural Engineer Partner of the firm. We had excellent working relations with one another. Mr. Gulzar Singh had a good collection of technical books and journals. Further, he had a number of design pamphlets of Portland Cement Association, USA and some rare design papers of foreign journals useful in structural design. For ten years I worked in the firm under the benign guidance of Mr. Gulzar Singh. Major projects handled by me during this period were:

- Nangal Fertilizers and Chemicals Factory, Naya Nangal
- Nangal Township Buildings

- Guru Nanak Engineering College, Ludhiana
- Dumex and Needle Factories, Chandigarh
- Ingot Factory, Jullundar
- IIT Delhi Buildings, New Delhi
- New Secretariat Building, Srinagar, Kashmir
- Bank Buildings, Sector 17, Chandigarh
- Medical College, Gauhati, Assam
- Medical College, Silchar, Assam
- Chanakya Bhawan, NDMC Building, New Delhi

- Dibrugarh University, Dibrugarh, Assam

I worked in Chandigarh for two years (1958-60). During this period, I remember two incidents which are worth recounting. The first is concerned with a serious error I made in the design of an underground structure of Nangal Fertilizers Factory. A huge mound of limestone was to rest on the top slab of a room-like buried structure. The scope drawings gave the equivalent UDL in kg/m^2 . At that period of time, we were working in FPS system of units. So I changed the given loading to FPS system and I got erroneously a value of 300 psf. Actually, this value should have been 3000 psf. But the design was done by me on the basis of 300 psf and the structural design and drawings were sent to the site for execution. When the steel of the base slab and the surrounding basement walls was tied at the site and the concreting was about to start, our site engineer, who was a senior engineer of considerable experience, found this error in my design calculations. Immediately, he stopped the work at the site and

talked to Mr. Gulzar Singh on the phone. Mr. Gulzar Singh called me in his office and very coolly told me to rework my design. He also directed me to keep the concrete sizes same, as those were already oversized and put new steel bars in addition to previous steel arrangement so that there should be a minimum of additional work at the site. I was quite worried at my lapse and I did the corrections as directed by Mr. Gulzar Singh and the corrected design and drawings were sent to the site and work was completed satisfactorily. What is important in this incident is the cool temperament of my boss, Mr. Gulzar Singh. He was absolutely cool and composed. He never said a word of admonition to me. His behaviour was absolutely remarkable. Later in life, I tried to follow his example. A junior's mistake is the responsibility of his senior, because the former is working at the direction of the latter.

The second incident is concerned with design of brick structures. I was given a load bearing brick house to design in Chandigarh. I finished the design and drawings and Mr. Gulzar Singh checked the drawings. He found brick wall footings atrocious. The basis of the design of brick walls is given in the Building Bye-Laws of Chandigarh Capital Project. Very coolly he designed before me a particular brick wall in all its aspects and then asked me to do the same for the rest of the walls. I completed the design of brick walls and got the structural drawings changed. Then, Mr. Gulzar Singh signed the drawings and those were sent to the site.

Mr. Gulzar Singh easily understood that undergraduate engineers at IIT Kharagpur or elsewhere, were not properly taught about the design of brick structures. In our times, brick structures and quantity surveying (estimating) were not taught adequately at the IIT Kharagpur.

In 1960, the firm of M/s Chowdhury and Gulzar Singh won the architectural competition of IIT Delhi. The head office of the firm was shifted from Chandigarh to New Delhi and I came to work in Delhi. The planning and architecture of IIT, Delhi are quite striking and outstanding in nature. The credit for it definitely goes to the firm and its staff. But, a lot of credit must go to Professor R.N. Dogra, the then Director of IIT, Delhi, who had an excellent artistic mind and he definitely extracted good work from architects and engineers of the firm.

In this project, I did the structural design of central workshop, heavy textiles laboratory, hostels, box-culverts, residential quarters, departmental buildings and some aspects of the main building too. In departmental buildings, a flat-plate system with artistic column capitals has been used. Main building of the Institute is a structural

marvel, designed by one of my senior colleagues. Many different types of staircases have been designed in the buildings and these are quite attractive and innovative.

About this time also, I was given to design New Secretariat Building, Srinagar (Kashmir). It is a shear-walled, six-storeyed structure with cellular raft-foundation. The soil capacity was given at 0.5 ton per square feet, i.e. 5 tonne per square meter. The soil testing was done by Central Building Research Institute (CBRI), Roorkee. Soil testing was not in vogue in those days and CBRI was specially requested to undertake this task. The design and drawings of this project were checked by experienced engineers of P.W.D., Kashmir and I was sent to Srinagar for a week to assist them in the work.

Medical Colleges at Gauhati and Silchar and Dibrugarh University campus were the prestigious works given to the firm for design. These were long-term projects. Earthquake forces were specially considered in the design of buildings of this region. Mr. Gulzar Singh

had a good insight into the behaviour of buildings under horizontal loads and he designed effective structural systems with shear walls and frames. He also had adequate literature published in USA for efficient structural design of buildings. At that time, there were few books available in the market for structural design of buildings. Foreign exchange situation of the country was also not happy so that it was not easy to get books from abroad. For reinforced concrete design, Reynold's Handbook (1956 ed.) was the only one available on the subject. Mild steel bars and ordinary concrete were the materials in vogue. Our codes IS: 456 and IS: 875 were also then in their preliminary stages. The structural designs then worked out to be quite conservative. Mr. Gulzar Singh had ACI Handbook and other American books, which led to savings in steel and concrete.

During this period, I had a strong urge to study further. Twice I got admission in M.Tech/M.E. courses in IIT, Bombay and the University of Roorkee. But on both occasions, my salary was raised and I could not study further.

Towards the end of 1963, Education Department of the Government of India selected 40 engineers for advanced training in West Germany. I was one of them. I spent 16 months in West Germany. The first four months were spent in learning German language at the Goethe Institute, Iserlohn and the rest of the twelve months were spent in working in German firms of different disciplines. I spent four months in Kaiserslautern in a firm to learn about reinforced concrete design as per German code. Then another three months, I spent in Saabrücken in a firm to learn about prestressed concrete.

I spent another month in Hannover in a factory which produced precast concrete members. The last four months of my stay in Germany were spent in Darmstadt where I worked in the firm of J.

Born to learn about shells and folded plates. During this period, I visited Berlin, Paris, Holland and Switzerland. There were very good (but expensive) books and periodicals in German language on structural engineering and I purchased a few of them for my use. By March 1965, I returned to India.

The firm M/s Chowdhury and Gulzar Singh accepted me back in my job with a couple of extra increments. My absence was treated as leave without pay. The design jobs were not too many in the office then. I used to keep myself busy studying the material I had brought from Germany. This was the beginning of my literary pursuits in the field of structural engineering. I propose to deal with this aspect in a separate chapter at the end of the book, as it is of special interest to me.

The firm at this time opened a branch office in Calcutta. I was transferred to the new office in Calcutta where we were designing projects for Assam. I remained in Calcutta for two years (1966-68). I

was called back to Delhi in 1968 due to the unfortunate and sudden demise of Mr. Gulzar Singh at the young age of only 44. It was a great blow to all of us working in M/s Chowdhury and Gulzar Singh. The firm was initially closed down and we all were left without jobs. I tried to get an alternate employment but the construction market was sluggish in those days after the war with Pakistan in 1965. Then we were forced to start our own firm of architects and engineers in the year 1968.

Chapter 3

Next Six Years Of My Professional Life (1968-74)

In this period my career touched not only its bottom but also its nadir. I lost my job of ten years standing and later I got a position in a leading firm of architects in Delhi and got the best job satisfaction of my life. Those were the bottom and top levels of my career.

Because of the prevailing recession in the market in 1968, we started our own firm of Maitra, Varyani and Madhan under duress. But our own work was quite more satisfying than being employed by others.

For about two years, I continued in this firm as the Structural engineer - Partner. I then had a great feeling of confidence. Among the projects handled during this period were:

- New Kotwali Building, Daryaganj, Delhi
- Hypar Shell Roofs for Fruit and Vegetable Market, Azadpur, Delhi
- Deen Dayal Research Institute Building, Jhandewalan, New Delhi
- Central Museum - Extension, Pilani
- Factory buildings in Faridabad
- Individual houses in Delhi

- Structural Renovation of Ashoka Hotel, Chanakyapuri, New Delhi

We had ten persons on our staff. We used to work hard for getting more work for the firm so that we could pay our staff in time and look after our own needs. Sometimes we used to work day and night. In that period, I joined IIT, Delhi as a research scholar for a Ph.D. programme in structural engineering. Upto that time, I had written about six technical papers and with my background of designing IIT buildings, I could get selected for the research scholarship of Rs. 400/- a month (for the period 1969-70). I then had eleven years of experience too. I used to attend M.Tech. classes and also cleared the examination of the first semester of the M.Tech. programme. It was a thrilling experience of attending classes after a gap of eleven years. In the second semester, the number of classes were reduced

in my case and I devoted more time to the review of literature for the Ph.D. topic which I had selected for myself as 'Interaction of Shear Walls and Frames'.

About that time of my life, I suffered a sudden bereavement of my second elder brother, who was very dear to me. This turned my mind Godwards and I read through all the eight volumes of Complete Works of Swami Vivekananda which were till then lying with me unread for a long time. Then I decided to do away with being a partner in the firm as well as continuing with my Ph.D. programme and look for a job as I had to support two families, mine and that of my deceased elder brother. I met directly Mr. N.K. Kothari of M/s Kothari and Associates, a leading firm of architects and engineers in Delhi. He was kind enough to make me incharge of the structural section of their Connaught Place office. The firm had a major structural engineering office in Sunder Nagar, where they had a chief engineer along with a few other senior engineers, working on several

projects. In my office, I had with me six structural engineers and three structural draftsmen. Then, I did not have to design by myself but I had to guide my young colleagues in designing buildings. I used to fix the steps to be used in the design of each building and I used to be with my colleagues to supervise and monitor their work through various stages.

Later, I used to check the structural drawings before those were sent to the site. Further, I used to attend meetings at sites of buildings as well as meetings with the clients. Also, I had to look after correspondence concerning those projects. It was a hectic time in the office. I remained in that office exactly for one year (1970-71). During this period, my section handled twenty seven projects, small and big. Some of the projects we handled were:

- Hansalaya Building, Barakhamaba Road, New Delhi
- Vandhana Building, Tolstoy Marg, New Delhi

- Tourist Transit Hotel, Dum Dum Airport, Calcutta
- JK Guest House, Chanakayapuri, New Delhi
- Dalmia Dairy Industries, Bharatpur
- STC/MMTC Staff Colony, New Delhi
- Payal Cinema, New Delhi
- Aligarh Muslim University, Aligarh

I had almost a free hand in the office. Mr. N.K. Kothari had an extremely busy schedule. He used to remain hardly a day or two in a week in the office. Initially, I waited for him to get his signature on official letters as was the custom in my previous office of Chowdhury and Gulzar Singh. But I found that by waiting for Mr. N.K. Kothari, my correspondence was getting delayed, affecting my work in the office.

So I decided to sign all the official letters myself and that way the speed of my work did not suffer. Later I found that nobody minded it. Further, if I wanted some money for buying a book or a code, I could get the same from the accounts department. They honoured my signature for these expense accounts. This sort of freedom was not available to me in my previous office. I used to attend many important meetings with clients on behalf of the firm and I used to work fast and independently. Mr. Kothari, though being extremely busy, used to know all about what transpired at different meetings. He had his own way of keeping in touch with his clients. I believed, he got favourable reports of my several meetings and I had a great rapport with my boss, Mr. N.K. Kothari. That was the best period of my professional life.

I achieved great success in planning of multi-storeyed buildings which were coming up fast in and around Connaught Place area. Hansalya Building had initially a central reinforced concrete core

encompassing lifts, toilets, stores, etc. The building had one basement, sixteen office storeys topped with another six storeys of a hotel. Initially, the core was central to the building so that it was like a tree-type structure, very easy to design for all the vertical and the horizontal loads. Later, our architects found that the core was coming in the way of the hotel corridor in the top six storeys. The core had to be shifted by about 180 cm off the centre-line of the building. It produced torsion in the building and also in the foundation. These torsional forces were to be resisted by the R.C. core as well as the huge pile group provided under it.

In Vandhana building, the pile foundations were complete when I joined Kotharis. I made a good contribution in the design of basement walls and design of columns. My colleagues were following a rudimentary method of column design. I brought strict methods of design of column and beam elements in the office practice and all my young colleagues appreciated those changes.

In the Tourist Transit Hotel building, the column size chosen by architects was 300 x 750. I would have liked the size to be 450 x 750. It was a 10-storeyed building. On analysis, we found that 300 x 750 size was not working out well. The steel percentage was working out to be quite high. Those days ordinary concrete of 1:1:2 mix was the highest grade of concrete in practice. I told our estimators to use M30 design mix in the building. There was no other way. All architectural drawings were complete with 300 x 750 column size. They were not willing to make any changes in the column size. So it was an innovation that had to be adopted in the building.

In Dalmia Dairy Industries project, there was an interesting incident to recount. Mr. Sanjay Dalmia called a meeting of architects in his office. I and my architect colleague attended the meeting. Mr. Dalmia was asking me about small problems in the structure of several buildings. I told him that I would clarify those items in a week's time. Later, he mentioned some unresolved architectural problems and my

architect-colleague gave him suitable dates for their resolution. In our next meeting with him, we both attended and on seeing me, he mentioned that he had received my answers to his queries within a week as promised. But he was very cross with my architect-friend as he could not keep to his dates. I used to be quite thorough and accurate in my approach and I used to regard dates given by me as sacrosanct.

In STC/MMTC housing project, I remember an interesting incident. It is a big complex on the Aurobindo Marg, near village Adichini, which is opposite to IIT. The flats were arranged in four-storeyed, six-storeyed and eight-storeyed blocks. Many contractors were awarded different sections of this huge colony. We had a band of good and efficient site engineers. In one block of six storeys, the excavated soil was found to be weak. The soil testing of this entire site was done by IIT Delhi and they gave a safe bearing capacity of 1.0 t/ft^2 . We had issued foundation drawings on the basis of 1.0 t/ft^2 . Site engineers

wanted me to inspect the site. On inspection, I concurred with their judgment that the soil in the block was not as strong as 1.0t/ft^2 , it should be taken at $\frac{3}{4}\text{ t/ft}^2$. The client's engineer was a retired army major and he also concurred with our opinion.

I returned to office and requested my colleague to redesign the foundation of this block on the basis of the reduced soil capacity. We made a special foundation drawing valid for this block only. I thought this problem had been solved. But after a week or so, I was told by my site engineers that one of our senior project engineers, incharge of this project, had an opinion that the soil was far too weak even for $\frac{3}{4}\text{ t/ft}^2$, it should have a value of $\frac{1}{2}\text{ t/ft}^2$. I was quite upset about this new input. The foundation cost would sharply increase with this change. I told them that the soil for this block should be tested afresh.

A single bore hole costing Rs. 3,000/- was made by IIT Delhi engineers. The extra cost was borne by our clients. They gave a result of $\frac{3}{4}$ t/ft² as per their tests and it was in line with my advice and our special foundation drawing was executed at the site.

During this period, I was trying hard to get a job in the Government sector, as I had already lost my previous job in a private firm earlier. Mr. Kothari's firm was running in top form and I had a good position and my work was being appreciated there. I appeared in interviews with MECON, Ranchi, EPI, New Delhi and finally with NIDC, New Delhi. I was selected by NIDC as senior engineer (structural). Mr. Kothari knew about my need to find a more stable job. So, with his blessings, I left Kothari's and joined NIDC, after working with Kothari's for exactly one year.

NIDC, probably wanted a design engineer of my background. In the interview, many senior engineers had participated. They asked me about my work with various architects. I told them that the building in

which NIDC had its office (Chanakaya Bhavan) was also designed by me, when I was working with M/s Chowdhury and Gulzar Singh. They urgently needed a design engineer to take care of their architectural projects. One of the Directors of NIDC was himself an eminent architect. So, they selected me for the post. Later, in Libya, I met a senior engineer who told me of this interview and mentioned that a Sindhi gentleman was selected. I told him that I was the Sindhi gentleman he was referring to. I worked for NIDC for three years (1971-74) and the projects designed by me were:

- Hindustan Cables Ltd., Hyderabad
- FCI's Food Grains Silos, Naraina, New Delhi
- National Productivity Council Building, New Delhi
- Talkatora Indoor Stadium, New Delhi

- Steel Rolling Mill, Tripoli, Libya
- Cost Accountants Building, New Delhi
- Indian Telephone Industries, Rai Barelli
- Instrumentation Ltd., Kota

In NIDC, the working system was different from that in a private organisation. NIDC was following many practices from the Department of Railways and also from Hindustan Electrical, Bhopal, many of the NIDC staff hailing from both these departments. There was a drafting pool on the eighth floor of the building. It made an impressive show. The entire floor was covered with drafting machines and draftsmen of all the departments were clubbed together in this Pool. An assistant Engineer was incharge of the Drafting Pool. Design engineers of various departments were working at lower floors in halls, rooms, etc. under the control of their

respective chief engineers. An engineer, after completing his design, was to make free-hand sketches, which were to be given to the Drafting Pool for making drawings. The drawings would then be checked by the design engineer and finally by the concerned chief engineer. In private organisations, we used to give design sheets directly to our draftsmen who would make accurate drawings quickly, which we would check right on the drawing board. The senior engineer or the partner would then check the drawings. The procedure was efficient and fast in a private set-up. In NIDC, draftsmen were reduced to just tracers, they had no need to think. Many engineers were using their junior engineers to make those free-hand sketches. Junior engineers were all graduate engineers, eager to learn design and they became frustrated on not finding any avenue for design. This procedure also brought down quality and generated frustration all round. There were many good things in NIDC also. Their library was excellent. It had a good collection of

books and periodicals. A senior engineer was made incharge of the library. NIDC also encouraged creative engineering to induce engineers to write out their new ideas, papers and articles.

A new aspect I learnt in NIDC was about the use of precast concrete in buildings. It was a Russian practice to use precast concrete columns in Factory buildings, on which steel trusses would rest. The precast concrete columns replaced steel columns. That way, we saved steel. Steel was in short supply then. R.C. Cast-in-situ columns of large heights would often go out of plumb and then steel trusses would not fit on their tops. For that reason, precast concrete columns of Russian practice were much favoured by NIDC engineers, who had earlier used the system in H.E. Bhopal. But the drawings of the precast concrete columns required a lot of care and thought in their making. All elevations of a given precast concrete column had to be made showing all the required insert plates along with their accurate positions. Those drawings were very difficult and

time-consuming to make and their checking was still more difficult. In Hindustan Cables Ltd., Hyderabad, we made extensive use of horizontal precast concrete members between columns at different levels to suit the architectural elevations. I became adept at conceiving joints between precast concrete elements. It followed the same pattern as those of steel members. The joint details of precast concrete members are quite similar to those of structural steel members. I enjoyed working on this project using precast concrete elements. My German experience and literature on this subject proved useful.

We had two good structural engineers in NIDC, one was a consultant, a post higher than a chief engineer, the other was our chief engineer who had joined NIDC after about a month of my joining it. FCI's silo design was nicely done by our assistant engineers with our help. Our chief engineer had also designed silos elsewhere. FCI engineers were also good in their checking. We

learnt from each other. The Head House Building was designed by me and I had used the method given in my paper on frames. That aspect was new to FCI engineers. Initially, they thought our approach was wrong. Later, they realised that our approach was the right one and they appreciated it greatly.

The contractors of the project at Naraina were also good at sliding shuttering. We all made a good group and the project was designed, checked and constructed to the satisfaction of all concerned.

Another prestigious project was NDMC's Talkatora Indoor Stadium. The 204 ft diameter dome with inclined columns was one structure and inclined seating structure all around was another structure, separated by an expansion joint. For shell design, a book by Salvadori was very helpful. I had first seen the book in the library of IIT, Delhi. Later, I saw the book in a bookshop in Connaught Place and I bought it immediately. It was a rare book. I made extensive use of the book in the design of the dome and our design was re-written

by our assistant engineer. It was checked by our chief engineer. Then it was further checked by IIT Delhi. They approved the design but wanted small ribs to be put in the domical slab for safety in buckling. The architects of NDMC then suggested to provide circumferential ribs on the inside and radial ribs on the outside of the dome to improve the looks of the structure.

In the National Productivity Council's building at Lodhi Road, New Delhi, the columns were spaced at 12.0 m c/c, a large grid for multi-storeyed buildings. The building was only six storey high with one basement. We used grid floors for 12.0m x 12.0m panels with precast concrete pyramidal elements to be used as shuttering for the grid floors. For resisting horizontal loads like earthquake and wind, we used shear walls in both directions as the columns in the building were less in number. The clients were happy at the large column grid used in the building as they got large meeting rooms on all floors.

About that time, we designed two folded plate roofs in NIDC office. Rai Barelli Factory had a span of 18.0 m and it was a trough shape and the Kota Factory had a V-shaped folded plate roof of span 14.0 m. I took keen interest in the design of folded plates in Germany and I had a number of papers and books on the subject with me. Further, I had the benefit of attending lectures of Professor K. Seetharamulu at the IIT Delhi during my research days there. In NIDC, I had a colleague Mr. M.C. Patel (now dead), who was an exceptionally brilliant and good structural engineer. He was equally good in reinforced concrete and steel structural design.

The Kota folded plate was designed by Mr. Patel. His input in the design of Talkatora dome was also exceptionally brilliant. That work on the design of folded plates was in my mind which later matured into my book on folded plates along with the co-authorship of my colleague, Mr. K.N. Taneja, when we worked together in Libya.

I would like to now recount a personal incident which occurred to me in NIDC office. Six senior engineers including myself were seated in a large room. Engineers, assistant engineers and junior engineers were seated in a large hall outside. Our chief engineer had a separate room on the same floor. Many young engineers used to come to me for discussing their problems. I had my own building to design and those young engineers had their own structures to design, the allocation being done by our chief engineer. In NIDC, we were under the direct control of our chief engineer and there were no other intermediate controlling officers. One day, a colleague of mine, who was an old hand in NIDC, told me that he wanted to give me an advice for my benefit. I was quite new in NIDC. I welcomed his offer and thanked him. He said that I was guiding young engineers and that was not my job. It was the job of the chief engineer. It was of no benefit to me and I should desist from doing it. I told him that I had a feeling that I had a short life. So, whatever little knowledge I had, I wished to distribute it to my young colleagues. He did not expect this

reply from me and he went back to his seat. This incident shows how shallow we think. Knowledge increases while sharing it. By being open with my colleagues, I got to know about the design of all the projects being handled by them. Otherwise, I would know only about my own building. That would restrict my knowledge. I have been always an open-minded person and I believe it pays to be open-minded.

After about three years work in NIDC, I got selected for a foreign assignment in Libya. I had put my name in the Register of Engineers and Doctors willing to work abroad. That was way back in 1969 when I had my own firm. NIDC was informed about my selection by the Government of India and was requested to spare me for this assignment in public interest. The Managing Director of NIDC called me in his office and said that I had not applied through proper channel. I politely informed him that way back in 1969 I had applied through my own firm, when I was not working with NIDC. I was

allowed a lien of two years. I was preparing to go abroad. At first I thought of declining the offer, but some friends suggested that it was not advisable, as later this might block my way to go abroad for all time. So I closed my establishment in Delhi, left my family with my in-laws and took a flight for Tripoli (Libya) on 4th March 1974, via Athens and Benghazi. I reached Tripoli on 6th March 1974, where my friends greeted me at the airport.

Chapter 4

Next Ten Years Of My Professional Life (1974-84)

From Tripoli I was sent to Derna (north of Libya) to join a construction company under the Ministry of Housing. There were already a few Indian engineers working in the company. We were staying in a house with two engineers occupying one room. The living conditions were cramped and not at all satisfactory. It being a construction company, we engineers were asked to supervise construction of structures, being constructed by a Yugoslavian company. I found

myself a misfit in this company, being all along a design man. I wrote to the Chairman of the Libyan company and requested for a suitable placement in their design section.

My Indian colleagues tried to put fear into my mind so that I might stay put in Derna. They even suggested that construction work was quite simple and that they would help me out, if I found it difficult. I told them that I loved design of structures, that I would like to do good design work in Libya and leave some mark there, that I was not there only to make money somehow, but that I was not afraid to go back to India if the company so desired, as I had a lien with my parent department. Shortly, I was transferred to Tripoli where they gave me some pending design jobs and also I was asked to check the design of silos being constructed in Tripoli by a Polish company.

After about six months, my family joined me in Tripoli and I had my own establishment and life became comfortable and normal. After a year in the Libyan Construction Company, I was transferred to the

Central Design Organisation of the Ministry of Housing in Tripoli, where about twenty Indian engineers were already working as expatriates. My lien with NIDC ended when I could not return to India after two years. Then I continued to be with the Ministry of Housing till 1984. I designed many reinforced concrete buildings of various types like - residential buildings, hotels, hostels, office buildings, workshops, schools, auditoriums, water tanks, training institutes, etc.

Work in the office was being done at a languid speed, with the Egyptian engineers and draftsmen setting the pace. The office hours were from morning 7 to 14 hours in the afternoon, with Friday being the weekly holiday. I used to study quite a lot, as I had a lot of free time at my hands, even during the office hours and many questions in my mind regarding structural engineering were being worked upon.

We were a group of intelligent Indian engineers and we had a free discussion on many topics of structural engineering and we benefitted a lot from those discussions. We checked two projects of foreign consultants. One was a project of Naval Academy, designed by British Consultants. They were using manual methods of design and their design calculations were similar to ours. Their designs were conservative. Particularly, their concrete sizes were on the high side. We convinced them to bring down those sizes. At the fag end of my stay in Libya in 1984, I was associated with the checking of Tripoli Sea Front Development consisting of five Tower Blocks of 18 storeys each, along with many low-storeyed structures. Daewoo of South Korea were to design and construct this complex at a lump sum figure.

The structural engineer in the project was an American of Korean descent. The structural design was on the underside as it often happens in lumpsum contracts. For six months I worked on those

designs and had long meetings with Daewoo and I succeeded in getting from them revised designs and drawings acceptable to International Standards, which resulted in an increased cost to Daewoo.

During my sojourn in Tripoli, I had written two books and seven papers. I have devoted a separate chapter to my literary pursuits.

Our Libyan officers were intelligent engineers, having been educated in either England or USA. They particularly knew how to conduct meetings. Many of the projects in Libya were designed and constructed by foreigners. Firms from Poland, Hungary, Yugoslavia, Bulgaria, India, Turkey, etc. were active in Libya. We, expatriate engineers, were required to supervise and check the work of foreign firms. In the office, our Libyan officers would put a problem, without prior intimation, to one or more engineers (without their knowledge) and asked for a report. After the report was submitted, we would think that the matter was over. However, after a few months or even

a year, the matter would be brought up again. Reports of different engineers would be put before a meeting and divergent view points expressed in the reports would be justified by the engineers involved and the Libyan engineers would enjoy the fun. But the Libyan engineers were quite intelligent and sharp. They could gauge the capability of each engineer. This must be said to their credit.

Libyan engineers found it quite difficult to get work from foreign engineers. They devised a facile method of insisting on us being in our seats, all through the office time, failing which we would be deemed to be absent and then would lose our salary for the day. It looked funny but it was true. Further, I used to miss our casual leave of 12 days a year, as is customary in India. There was no provision of causal leave in Libya. Even if one was ill, one had to attend the office. Later, during office hours, one might visit a government doctor, who might recommend leave. One could then proceed on leave after

informing the office. A person seriously ill would find that procedure tortuous and unbearable. We were then young and went through those procedures without much loss of composure.

Once there was a failure of some check dams built by a Yugoslavian company on account of a flash flood. It was a routine affair to constitute a committee to enquire into the causes of failure. A committee of Indian engineers was formed to investigate the cause of failure of the dam. It was also customary to put engineers of one country against those of another in order to avoid any possibility of collusion of professionals. This only indicated the feeling of suspicion Libyans had of foreigners in general. We studied the reasons for failure and gave our report, which was much appreciated by the Libyan officers.

We had many Egyptian engineers, architects and draftsmen in our office. They knew English as well as Arabic. We got access to many good books on civil engineering published in Egypt. The

development of Egypt is similar to India's. I later visited Cairo and it had some similarities with our city of Calcutta (now known as Kolkata).

I returned to India in March 1984. The Government of Libya was quite fair to expatriates and all the terms of the contract were honestly fulfilled by them. Life in Tripoli was quite peaceful and comfortable. Our Libyan colleagues gave us a lot of respect and regard. Ordinary Libyan in the neighbourhood was also quite friendly. Children's education was provided upto 12 class in the Indian Community School in Tripoli, Health care was also adequate in Libyan Government Hospitals, many of the doctors and paramedical staff being of Indian origin. Life had nothing much to desire for, though I returned to India for family reasons.

Chapter 5

Last Nineteen Years Of My Professional Life (1984-2003)

At the end of my foreign assignment in Libya, I joined M/s Kothari and Associates, Architects and Engineers, New Delhi on 1st June 1984 and worked in this organisational till 31st March 2003. I had to stop working as my health deteriorated. During this period I handled the following projects:

- Hospital projects in New Delhi, Bangalore, Hyderabad, Singrauli, Kamptee, Gevra, Jaipur, Chandrapur, Kanpur, Bhopal, Bilaspur, Basti, Patna and Talcher
- Group housing projects at Noida, Faridabad, New Delhi, Jaipur, Bhondsi
- BPCL office complex, Noida
- Anti-Pollution Board Building, Shahdra, Delhi
- PHD House Extension and Conference Hall, New Delhi
- RDSO Auditorium, Lucknow
- Water Towers at Dehradun and Nandlur (A.P.)
- Indian Oil Management Centre, Gurgaon

- Modern School Extension, New Delhi
- Museum Complexes at Bhopal and Bhubaneswar
- Forest Research Institute, Dehradun
- G.B. Pant Institute, Pantnagar, Kumaon
- Wildlife Institute, Dehradun
- VSNL Buildings with towers at Jalandar, Ernakulam, Bangalore, Chennai and Kanpur
- Garhwal University Complex at Srinagar (Tehri)
- Nigerian High Commission, New Delhi
- Solarson Factory, Baroda

- Videocon Plaza, Renovation, Jhandewalan, New Delhi
- A.C.C. Degree College in Himachal Pradesh
- Honda Car Factory, Greater Noida
- Piccadily Hotel, Lucknow
- Oman Embassy, New Delhi
- Uzbek Embassy, New Delhi
- New Circuit House, Srinagar, Kashmir
- Apparel Exports Promotion Council's Complex, Gurgaon
- HPCL Buildings, Visakhapatnam

- WALMI Institute Complex, Lucknow

I had a group of structural engineers and draftsmen working with me and I used to guide them to design and draft these projects. Till I attained the age of 58 in 1994, I used to design buildings myself as well as to guide my colleagues. At all times, structural drawings were checked and signed by me. However, after 1994, I stopped designing but allowed my colleagues to take care of all aspects of design of building projects under my charge, I devoted my time to write out two books - one on the design of multi-storeyed buildings and the other on biaxial bending of reinforced concrete sections. During this period of 19 years, I wrote 27 papers also.

I shall now recount some of my experiences in the design of buildings. We were given to design BPCL office complex in Noida. It was a prestigious work and I deputed my experienced associate to take up this work. For some reason, his approach to design was shoddy and his column loads worked out on the high side and we got

a depth of 1.8 m for the slab-type raft foundation for this building. Earlier in the estimate, we had given a value of 1.5 m. Our estimate went hay-wire. I discussed this problem with my colleague and I found that he was not accurate in his calculation of column loads due to lack of concentration. Immediately I withdrew this work from him and took up this project in my hand. The column loads now came on the low side and we got a raft depth of 1.5 m as estimated earlier.

In structural design, we should be accurate right from the start of calculations and no rounding off should be allowed at intermediate stages of calculations. This project had many interesting features like an auditorium and a free-standing staircase. I enjoyed designing this project.

Anti-Pollution Board building at Karkardooma, Delhi had many interesting features. In the laboratory building, the architect had used double columns so that drain pipe could be put in between the double columns. This was the system adopted in a similar building in

Nagpur. The main office building had cantilever projections at each floor with increasing cantilever spans. Then, there was a 20.0 m bridge span between the office and the laboratory buildings. I had designed the buildings carefully. I had designed the buildings in two alternate ways so as to get at the correct column loads. Design calculations and drawings were sent to the client and they gave this work to an experienced outside engineer for vetting. He gave his comments on our design calculations and drawings and our architects were in a tizzy about his comments. The letter was forwarded to me for my reply. I studied the comments and I knew the experienced engineer. He was my senior in the office of M/s Chowdhury and Gulzar Singh in the years 1958-62. I gave suitable replies to all the points raised by him. Later, we had one-to-one meeting along with the engineer of the Board. I did not agree to any of the points raised by him and he had to agree with me and he gave a remark, that Mr Varyni had become quite tough. Later, a CPWD engineer was deputed to the Board for execution of this project. He

also raised some points on the design. I explained to him our position. But he was quite adamant. Then we had a meeting with the Engineer-Member of the Board. There all the points were discussed in the presence of the CPWD engineer. The Engineer-Member agreed with me on the points raised in the discussion and the design and drawings of the project were approved. I used to visit the site periodically and later the CPWD engineer and I became good friends. We remained in touch with each other for a considerable period of time.

Mr. Anup Kothari of M/s Kothari and Associates is an expert on Hospital Design. He may have designed about fifty hospitals spread all over the country. I would have done structural design of about twenty five hospitals in association with him. Escorts Hospital was the first hospital I designed in Delhi after my return from Libya in 1984. This was at first designed by another firm of architects with a structural engineer of Bombay region. In Escorts Hospital building,

we had a single basement. As the site was near the Yamuna river, ground water table was quite high in the area. The Bombay engineer suggested use of a diaphragm wall which proved to be quite costly. The project was withdrawn from the architects and it was given to Mr. Anup Kothari. We suggested use of reinforced concrete cast in-situ basement walls with a dewatering procedure to be adopted during construction time. This system of basement construction proved reasonable in cost. The building was constructed in record time.

Then we got a prestigious work of Indian Institute of Cardiology, Bangalore. It was a large project. Our design was checked by a leading firm of consultants in Bangalore. The work of construction started. Later, the hospital authorities suggested to us to appoint a local consulting engineer to help us check steel, etc. at the site. Instead of doing this work, this engineer started checking our structural design at the instigation of some hospital engineers. He came to the conclusion that steel used in our drawings was on the

high side. Initially, I replied to his letters and explained to him that the design calculations as given by us were correct. Later, I realised that this engineer was getting paid by us but instead of helping us at the site, he was checking our design for which he was not appointed. I wrote to him to desist from this extra work and we stopped his payment. Then he went to the Court under Public Interest Litigation (PIL).

He mentioned several points in his petition. I also wrote effective counter-points and his petition was rejected by the Court. During this period, we had several meetings with the senior engineers of the PWD Karnataka, who were supervising this work and we succeeded in convincing them of the accuracy of our calculations.

In Indira Gandhi Institute of Medical Sciences, Patna, we used pile foundations on the advice of Mr. V.R. Vaish, Retd. Director General of CPWD. Our structural drawings were checked by CDO of CPWD. We

had good interaction with the CPWD engineers. The project was constructed by M/s. NBCC Ltd. After this project, I finalised my paper on pile foundations.

In Basti, we designed a big hospital for the Department of Health, UP. The contractors were UP Nirman Nigam. They made a mistake in the construction of the ramp provided in a section of the hospital. A part of the ramp was showing cracks due to construction defects. They tried to put the blame on the designers. But large portions of ramp were standing well and we showed them that our structural design was correct. But the deflection provisions of IS:456-78 are not coherent and so they are still prolonging the case.

Large projects of Apparel Export Promotion Council (AEPC), Gurgaon and Indian Oil Corporation (IOC) Management Centre, Gurgaon, were designed by us with many special features. We used shrinkage strips in the basement walls and ground floor slabs of the huge basement of the AEPC project. We did not provide any

expansion joint in the basement storey. Expansion joints with double columns and double beams started upwards ground floor level. Tower blocks of AEPC project were provided with flat plate floors designed for earthquake loading. IOC project was constructed by NBCC. It was a large work with many special features.

In Visakhapatnam, we designed three large buildings for HPCL, the design being governed by large wind forces. We had good interaction with HPCL engineers at the site.

We renovated an existing building of V-Plaza in Jhandewalan, New Delhi. It had double basement. We added three more storeys on top, with extra wings at lower storeys. We added some escalators and lifts in the building. Due to large underground water in the area, we supported heavy generators at the first basement floor level. We had to strengthen the floor slabs and beams to support these heavy loadings. The second basement was used only for parking. There

was an underground water tank below the second basement floor. The V-Plaza building has an attractive curtain wall elevation and it stands out of the surrounding buildings.

We designed for VSNL heavy buildings with high transmission towers resting on top of these buildings in five cities all over India. The buildings and tower supports were designed for large vertical and horizontal loads due to earthquake and wind as applicable.

In a group housing project at Dwarka and also in Sukhi Jiwan flats at Jaipur, the clients complained about excessive consumption of steel in reinforced concrete members. We had long meeting with our clients and convinced them that we had no vested interest in putting more steel in buildings than required. We put steel in buildings for their safety only. Later, the clients in Jaipur informed us that their flats were selling well, the buyers being impressed with the amount of steel in columns.

In AWHO flats in Noida, the contractor had not done proper curing of certain slab panels. The panels were vibrating under impact, the contractor was asked to quit and the work had to be stopped. We identified these slab panels and demolished the existing poor quality concrete panels. These poor quality panels were re-constructed, completed and cured well with the help of a new contractor.

We designed a 20.0 meter conference hall for PHD House in New Delhi, the roof of the hall was of a pyramidal nature. We designed it as a space truss with a perimeter octagonal beam at the base. In the structural drawing, we gave only a typical section of this important beam. We went to the site for checking steel in the pyramidal roof. Suddenly I saw that the top and bottom bars of the base beam had no laps at the column locations. The base beam was under tension and the top and bottom bars had to be continuous for its safety. Immediately, corrective steps were taken. We could spot this

important omission in the nick of time. Later in similar projects, I used to insist on a plan of the octagonal base beams so that this sort of blunder could not take place at site.

We built Honda Car Factory at Greater Noida in a record time of six months. The factory buildings were built in structural steel and the rest of the buildings in reinforced concrete. Our Connaught Place office took care of the steel structures and my office did the reinforced concrete buildings and also machine foundations. We had a hectic schedule and had the satisfaction of completing the project in time.

In Janakidas Building at Mall Road, Shimla, we got the experience of building on a hill side slope. The building had an opening at the Mall Road and then another opening at the lower bazaar road which is three storeys lower. The entire building was six storeys. The top roof had steel trusses. The attic was used as a drawing room. The

foundations at different levels posed tough problems. Similar problems were faced by us in ZSI building at Solan, Himachal Pradesh.

In HCL Housing complex at Noida, we faced an interesting problem. The client had two identical plots of land. He engaged two different architects for constructing flats at those two plots. The covered area had to be the same. The two architects produced two different designs of flats. After approval, the construction at the two plots began at the sites by two different contractors. The client later pointed out to us that our design was consuming more steel than the design submitted by the other architect. We told him that our rooms were bigger, we had not put an eyesore beam between the drawing and dining rooms and we had provided RC parapets for earthquake reasons. On all these three points, the other design was deficient. The client was satisfied but he got the brick parapets changed to RC parapets in the design of the other architect.

In New Circuit House Building at Srinagar, Kashmir, we faced a difficult problem. The soil at the site was weak. The soil report gave a value of $5t/m^2$. We provided a slab-type raft foundation. In order to be on the safe side, we provided wooden piles at 1.2 m c/c in both directions in the raft-pit to consolidate the soil. It was well appreciated by the clients. This is a common practice in Calcutta region, where too the soil is weak.

A common impression of clients is that buildings consume more steel than what is necessary. My main task in my career had been to convince my clients that we have no interest to use more steel in buildings than what is absolutely required for their safety. The steel shown in our structural drawings comes from our calculations and we do not provide steel more than the calculated steel. I always have faith in reinforced concrete as a material and also perfect faith in our

methods of design and codes. My faith has stood the test of time. I have designed so far about 2000 structures, big and small, which have stood well and have given so far no problem.

As a design engineer, I used to prefer to work in office. We had separate site staff. Our design engineers were not required to visit sites. For design, a certain amount of concentration is required. So, I would not encourage site visits unless absolutely unavoidable. A certain incident happened in Noida, for which I had to visit the site. An overhead water tank of small height (about 10 m above ground) had a problem that it moved when a few workmen moved it one way. It so happened that a shuttering portion inside the tank got stuck and the workmen applied some force to bring out the shuttering piece but the tank moved visibly frightening the workmen and also the client. The matter was reported to our designer in the Connaught Place office. He examined the design and the drawings and visited the site but could not find out the reason for this behaviour. The matter finally

was referred to me. I went to the site and I saw that the foundations and the plinth beams of the tank were still exposed to the view. Normally, we fill up the foundation up to the plinth level. Then, a few workmen were sent to the top and they went inside the empty tank. All of them pushed the tank in one direction. The tank moved visibly. I told the workmen to come down. I found the columns and braces of the tank were safe and uncracked. The design of the tank was earlier checked by me to be oversafe. So, I came to the conclusion that the tank was safe. The deflection at top is nothing but its elastic deflection which is normal for a cantilever under horizontal load. This was a small tank so a few workmen were able to move it. The same phenomenon is possible for all overhead tanks. Therefore, there was nothing to worry. The structure was safe. The plinth was then filled up and tank was filled up with water for use. So, problems sometimes crop up without any rhyme or reason.

Till 1993, we had the fatherly care of Mr. N.K. Kothari. Later, his two worthy sons carried on the traditions of this great organisation. I had a good rapport with both of them and they gave me great respect and regard. But architects do get into some problems with their structural engineers. In one meeting, I was asked when the foundation drawings of a building would be ready as the construction activity starts with foundations. I replied that I would give foundation drawings two weeks after I got the final architectural drawings. My architect-boss did not appreciate my answer. He had expected that I would commit myself with a date for supplying foundation drawings. But I knew that any date given by me would not hold unless I got final architectural drawings. Structural design work can only commence after architectural drawings are finalised. So, there often remains some tension in relations between architects and their structural engineers. But I was lucky to get away with such tricky situations without any obvious harm.

Of late there has been a sea change in design procedures. Previously, we were working by manual methods of design. All my books and papers give manual methods of design. But recently computer programs have come in a big way to entirely replace manual methods. After some initial hesitation, our offices have been using computer programs to design all buildings, big or small. Our young engineers have become adept in using computer programs and interpreting their results. The work output has improved. Architects often make many changes in their drawings. Now these changes can be easily incorporated into structural design by using computer methods. This aspect is a great advantage of computer methods over the manual methods. Computer programs are expensive and these all are not foolproof. Some inherent defects may creep into the programs for which there may be no accounting. The structural engineer is responsible for the safety of structure, not the computer program or its promoters.

In 1998, my senior colleague, Mr. J.D. Buch, incharge of our Connaught Place office decided to retire after thirty five yeas of distinguished service. Then I was called upon to look after both the offices of M/s Kothari and Associates in Delhi. I used to attend each office on alternate days. I appointed local supervisors to look after the daily chores. I used to check all structural drawings and also attend to the correspondence in both the offices.

All this work was very easy for me. I was quick to take decisions and I used to dispose of all correspondence on the day I received. I used to delegate to my juniors as much work as was possible to do. I gave them a lot of autonomy. They were under me only for technical guidance. In other aspects, I used to regard them as my equals. We had, in general a good and comfortable working environment in both the offices.

Around January 2003, I developed pain in my stomach. This development was quite sudden. After a lot of testing, the disease was diagnosed to be pancreatitis, i.e. inflammation of pancreas. I lost about 10 kg of weight and became weak. I decided to retire. I was then of 67 years of age. I was, anyhow, thinking of calling it a day. This ill-health was more than an adequate reason for my decision. In order to divert my mind to spiritual matters, I decided to retire from engineering as well. I donated all my rare collection of books and journals to M/s Kothari and Associates, for the benefit of my young colleagues. On 31st March 2003, a farewell party was organised in the Connaught Place office of the firm. The office gave me a silver plaque as a souvenir and my colleagues gave me a set of Collected Works of Swami Vivekananda along with photos of Sri Ramnakrishna Parmahansa, Swami Vivekananda and Sri Sarada Ma. These are my prized possessions now.

Chapter 6

Literary Pursuits

From Germany, I had brought in 1965 a lot of books, periodicals and hand-written notes on some topics of structural engineering like shells, folded plates, precast and prestressed concrete and design of staircases of various types. This material was not easily available in India then. I was studying it even during office time as the work in the office of M/s Chowdhury and Gulzar Singh was then on the low ebb temporarily. I prepared a paper on the analysis of framed and shear walled buildings and sent it to the Indian Concrete Journal (ICJ) for publication. After sometime I got a reply that the paper could not be published in the journal as there was a huge pressure on their

space. Later, I came to know that that was their standard reply. They would not comment on the deficiencies of the paper. I was highly disappointed. Later, I realised that the paper was quite long and multi-pointed. Anyway, I kept that work on the side and started working on design of reinforced concrete columns. We used to design columns by Reynold's Handbook (1956 Ed.), Handbook of Concrete Association of India (CAI), and Handbook of American Institute (ACI). These three methods led to three different results in a given example. I delved deep into the subject in order to understand the reasons for these variations. Another method was given in the book of Applications of Moment Distribution published by CAI, which was called equivalent axial load method of design. It was based on ACI code. It was a very elegant method of design applicable to columns under uniaxial as well as biaxial bending. I changed the ACI method to our Indian code IS:456 and prepared a paper and sent it to the ICJ. Luckily, it was accepted for publication and it came out in December 1967. What a joy I felt then! It was my first published

paper. The paper was well received and it was used in design offices for some period. Soon Handbooks based on the working stress design and ultimate strength design were published by the Structural Engineering Research Centre (SERC), Roorkee and these supplied convenient charts based on IS Code for design of columns under uniaxial bending. Biaxial bending of columns still remained a problem. It was my experience that if one delved deeply into a problem, it would bring out a lot of ideas. On column design, I wrote three other papers, including one on biaxial bending of columns. Some of these papers, I wrote together with my engineer friend, Mr. P.L. Assudani, who was then in CPWD, Calcutta. We made a good partnership.

Later, I revived my first discarded paper on frames and shear walls and with the help of Mr. Assudani, we brought out two separate papers, one on framed buildings and the other on shear-walled

buildings. These papers were published in 1968 and 1969. The paper on shear walls got a mention in the reference columns of the journal, ACI.

After 1968, there was a lull in my literary activities. I had lost my job of ten years standing and I was busy with the nitty-gritty of life. Work in the offices of M/s Kothari and Associates and NIDC was quite hectic. In NIDC, I worked on the design of folded plates. In my research at IIT, Delhi, I had attended lectures of Prof K. Seetharamulu on folded plates. From Germany, I had brought a lot of literature on folded plates. When I went to Libya in 1974, my mind was full of ideas on folded plates. There was a lot of time available to me in Libya. I wanted to make ready-made tables for design of folded plates, if not for final analysis but at least for primary analysis. I took up a case of five-plate northlight folded plate. Using Simpson Method, taught by Prof. Seetharamulu, I succeeded in deriving formulae not only for primary analysis but also for secondary

analysis. That way, the ready made tables could be made for northlight folded plates for certain range of suitable parameters. I was solving some problems given in the literature by using a slide rule. Later in Libya, I bought my first calculator in life. What a joy it gave me then! Slowly, I solved many examples and verified the correctness of the formulae derived by me. I then made a paper and sent it to ICJ. Unfortunately, it was rejected. Perhaps, it was too long for the journal!

Next, I worked on the V-shaped folded plates. I derived the formulae on the basis of Simpson Method and with the help of my Casio calculator I prepared design tables for a certain range of parameters. I prepared this paper and sent it to the journal of ACI, USA. It was rejected, but they gave reasons for rejection. They mentioned that in USA folded plates were then being designed by suitable computer programs which were based on the method of elasticity and not on an approximate method like that of Simpson. I understood and

appreciated their objections but I still felt that those tables for analysis of folded plates would be useful for Indian engineers and also for other engineers the world over, because computer programs were not within the reach of every engineer, while those tables, when published, would be easily available to all interested engineers.

Similarly, formulae for other shapes of folded plates like trapezoidal shape, trough-shaped, symmetrical and unsymmetrical shapes were developed by me. For each shape, I solved one example on my calculator and compared the results to those given in the published literature. For deriving tables, I had to calculate each case separately over the calculator. It was a very long task for me. Then entered my friend, Mr. K.N. Taneja into this subject. I shared my problems with him. He possessed a good knowledge of folded plates and had designed some folded plate structures in practice. He suggested that his brother in India could produce programs for us on the basis of our formulae for each shape and the computer would give then design

tables for a large range of parameters. It was done and with the kind assistance of Mr. V.B. Taneja, a large number of tables became available to us. We selected the useful range of parameters and prepared a book 'Design Tables for Folded Plates' which was published in India in 1982. In the book, we added two full scale examples of folded plate structures. Also, a chapter on the design of reinforcements in folded plates and the supporting traverses was added. It was a complete sort of a book. We had completed the book in 1978 but our publishers in India took more than four years to bring it out. The delay in publishing the book was often a matter of despair to us. But on publication of our first book in life, our joy was unbounded. We received from the publishers ten free copies which we distributed to our friends in Libya, who had been very helpful to us during the preparation of the book. We then had a plan to work on the second volume of the book in order to extend these tables to the design of continuous folded plates. However, due to the delay in publication of the book, we could not make much progress on the

proposed second volume and the work was left incomplete. Later, in India I published a paper on analysis of continuous folded plates in ICJ September 1991. This paper was also noticed and mentioned in some international journals. This sums up my work on the analysis of simply supported and continuous folded plates of different shapes.

Then I turned my attention to reinforced concrete design based on IS:456-1964. SERC's Handbook on ultimate strength design method was with me. I was working on the derivation of the charts for design of columns under uniaxial bending. I found some interesting discrepancies with available charts. Then I came to know in Libya that IS code had been revised and the new code IS:456-1978 had come out in the market in 1980 along with an IS Handbook called Design Aids. I obtained both these publications from India and started working on the new code.

During my ten year stay in Libya, I published seven papers in Indian journals, two of these papers being in partnership with Mr. A. Radhaji and Mr. R. Subramanian. A paper on the spacing of expansion joints in building was much appreciated. It also gave a method of including the effect of temperature into structural design of buildings. This aspect had remained obscure in the existing literature. Also I wrote three papers on the deflection of reinforced concrete slabs and beams in the light of the new code (IS:456-1978). Further, two papers were written on the design of rectangular and non-rectangular beams. A paper on the biaxial bending of beams was published in 1982. It gave design aids which were then not available elsewhere.

My second book 'Manual for Limit State Design in Reinforced Concrete Members' was published in 1984. This was a useful book for design engineers for their day-to-day office work. I put in this book many useful design aids developed by me for my personal use. The

book covered slabs, beams, columns under uniaxial and biaxial bending, isolated footings, cantilever retaining walls, liquid retaining structures, expansion joints, solid and hollow circular columns and slender columns. I needed help from my colleagues which was provided by Mr. A. Radhaji as my co-author. Mr. Kuldip Singh, my young engineer-friend gave me great help in preparing sketches and charts.

Technical books did not bring us much royalty. We received royalty for initial two years only that too of about Rs. 1,500/- a year for each author. It was actually peanuts. For the third year, the publishers said that the sale of books was not much, so no royalty was paid to us. Our first book on folded plates is still alive and it is available from the publishers. Our second book sold well but soon it went out of print. Though in demand, the publisher could bring out its second edition only in 2001. I added seven new chapters to the book and it is now much in demand by the engineering community.

On return to India in 1984 till my retirement in 2003, I wrote another 27 papers on various topics. On foundations, I have written two papers, one on pile foundations and the other on footings for columns on the property edge. Deflection of two way slab panels and flat slabs formed the subject of two papers. Biaxial bending of rectangular and triangular column sections was given in four papers. A major overhead tank resting on a circular thin shaft failed suddenly in Noida. It provoked me to prepare an incisive paper on the design of such structures. I pointed out pitfalls in the code and the existing textbooks written by leading academicians and brought out the cause of failure of thin shafts to be local buckling. I wrote papers on items like computer versus structural engineer, role of checking engineers, on how to reduce steel consumption in buildings, etc. Some of these papers were written in partnership with Mr. Rajan Abrol and Mr. P.C. Nirala.

In 1994, when I attained the age of 58 years, I decided to stop designing structures myself and restrict myself only to checking the work of my young engineers in the office. I had time on my hands and I then decided to write a third book of my career as an author. It was on the design of multi-storeyed buildings, a topic in which I have been working all along the years. I finished the manuscript on 18th November 1994, but the book came out on 26th June 1999. Again, it took my publisher (a different one this time) more than four years. It was a frustrating experience. The book was well received in the market. We brought out its second edition in 2002 with an addition of two more chapters and some more useful tables in its Appendix II.

On 28th September 2002, my fourth book on 'Biaxial Bending of Reinforced Concrete Members' came out of the press. I had earlier published seven papers on biaxial bending of columns of various sections. These papers have been brought together along with some

other useful material to make the fourth book. I have spent my lifetime on this difficult topic of biaxial bending of reinforced concrete sections and it gave me a great satisfaction to publish this book.

I have written in all forty papers spread over my entire career of forty five years, all on the design of structures. The subject-wise distribution of papers is as follows:

Columns	6
Deflection	8
Beams	2
Foundations	2
Folded plates	1

Multi-storeyed buildings	14
Biaxial bending	7
Total	40

It takes about one and half year to publish a paper. I have got published four books. Two of the books took 4½ years each to get published and the other two took about a year each. Two of my books got their second editions also. Literary writings have kept me active and alert in my entire professional life of forty five years.

Chapter 7

Retrospection

I am a structural engineer of medium category. I am not one of the top engineers of India. I can think of about a dozen names, who are the best engineers practising in India. The world top engineers may be quite a way ahead of our best engineers. There is no highest level in excellence. There is much to be tried and achieved, I fall in the middle rung of engineers. Quite a few engineers are ahead of me, but many may be below me as well. I thank God for what I achieved in life. I am now a contented man and much at peace with

I spent all my professional life in the field of structural design, a subject of my love. I thank God for all the job satisfaction I got from my professional life. I have remained faithful to my subject and I did not change my line of work despite pressures.

Structural designs of important projects are subject to peer checking. It is a very challenging task to defend our design before other engineers, who are as competent as anyone else. I always feel that it is easy to explain a point in design to oneself but the same is difficult to explain to others and convince them that this is the best one can get. As Sri Ramakrishna Parmahansa said that 'it is easy to kill oneself (a penknife will suffice for the task) but to kill others you need a sword and a shield'. So for discussing our design with others, we need to have reference books, journals, codes (sometimes foreign codes too) in order to defend our design successfully. I had, in my career, several encounters of this nature with other structural

engineers. Often, it was a question of learning and of a give and take in such discussions. An egoistic approach could lead to cancellation of contract.

There is this question of corruption in public life, especially in the field of civil engineering. Government departments are much abused in this connection. In my view, public servants are a pampered lot in India. They get good emoluments, allowances, post retirement benefits and medical care all through the life. They have a further privilege of indulging in corruption when an opportunity comes their way. Ordinary citizens when their work is stuck in government red tape, have no other way to come out and the public servant instead of serving the public, commits a positive disservice to it. In private sector, in general, there is no such opportunity with privately employed persons. In private sector, job security is nil unless the employee is exceptionally good and efficient. Corruption is much less in private sector.

God has protected me from corruption in my professional practice. In 1969, we got a job of renovation of a small school of a foreign embassy in Old Friends Colony. The job was small and we called quotations from a few contractors. One contractor was known to me and lived in my neighbourhood. He purchased the tender papers from our office and the next day he visited my home. He asked me what my percentage was in this job. I was taken a back at his query. I told him that we, as architects of this job, are getting our percentage from our client and that he need not even think about this aspect. I told him to fill in his rates and submit the tender in our office. Later, we found that his tender was the highest and he could not get the job. The rates filled in by him were not realistic. He should have devoted more time to his work rather than thinking of influencing the architects. We in India do not spend our energy in the right channels.

Another incident, I remember, is concerned with a concrete mix design which I had approved in a project. Normally, I reply my letters fast. I got a letter from the concerned contractor about approving concrete mix design before starting the construction. I studied the letter and gave my approval of the mix design with a proviso that cube tests at the site should give satisfactory strength results. At the site, our engineer was mentioning to other engineers that Mr. Varyani had approved concrete mix design so fast, hinting thereby that I might have received some gratification from the contractor. He might have been influenced from some previous practice before I had joined the office. I was busy with structural design of the project and had only one thought of not delaying the project. People have their own way of thinking. I am an ordinary person with many human failings. God has only kept me free from corruption in my professional life. I remain grateful for His grace.

Before partition of the country in 1947, load bearing bricks or stone wall buildings were common. Only a few reinforced concrete buildings were built in Delhi then. In government sector, the first R.C. buildings were Krishi Bhawan and Udyog Bhawan. The CPWD engineers who designed those buildings were regarded as very good designers. The spacing of frames in those buildings was only 12'-0" (3.6m). Later, architects wanted spacing of frames to be 4.5m to 7.0m. In hospital buildings, 7.0 x 7.0 grid was preferred. Recently, in some high-tech buildings in Bangalore and Hyderabad, 12.0 x 12.0m grid has been used with thin prestressed concrete, cast-in-situ slabs. Thin slabs lead to economy in multi-storeyed buildings. Hence, the prestressed concrete cast-in-situ slabs lead to economy and this system is widely used in USA.

The reinforced concrete code IS:456 has gone through many revisions starting from its first edition in 1953. Later revisions came in the years 1957, 1964, 1978 and 2000. I have seen through all these

revisions and have applied code provisions to practical design of structures. Working stress design was given in the 1964 version, while the limit state design was given in the 1978 and 2000 versions. In the 2000 version, new concrete mixes are given and covers over bars are increased. Steel consumption in buildings gets increased by some defective clause in the code IS:456-2000 which gives

$$U = 1.5 (DL + EQ)$$

instead of the correct formulation

$$U = 1.2 (DL + EQ)$$

This aspect has increased steel consumption in buildings. I have been relentless in getting this error corrected in the code.

This is the brief story of my life covering over forty five years in the field of structural engineering, which has been my love and passion. I have written this small book to take it out of my mind so that I am free from matters mundane and ready to explore matters of the spirit.