

Brief Bio-data, Contribution to IITB Community, Research Contributions Awards & Recognitions of Professor Tarun Kant of IIT Bombay

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FIE; FAeSI; MISTAM; MISTE; MISCES; FIndACM; FIASE; MIACM; FWIF

Date of birth: 1 July 1946

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Tarun Kant was born on 1 July 1946 at Ballia in eastern Uttar Pradesh, India. Passed his High School (10th standard) in 1958 from Queens' College, Varanasi and his Intermediate (12th standard) in 1960 from King Edward Government Inter College, Deoria, both in first division. He received his BSc degree from the University of Allahabad in 1962, his BTech (Hons) in civil engineering from the Indian Institute of Technology Bombay (IIT Bombay) in 1967 and MTech in civil engineering with specialization in structural engineering from the Indian Institute of Technology Kanpur (IIT Kanpur) in 1969. He spent about one and a half year in a consulting engineering firm in Mumbai before joining IIT Bombay on 20 January 1971 as a *Lecturer*. He earned his PhD degree while working as a Lecturer from IIT Bombay in 1977. He was selected as an *Assistant Professor* in 1978 and a *Professor* in 1986.

He has held the positions of the Department Head (2000-2002), the Dean (Planning) of the Institute (2001-2003), the Chairman of the prestigious Joint Entrance Examination (JEE-1998) and the Chairman of the Central Library (1995-1999) with great distinction. He initiated and introduced many innovations effectively during his tenure. The Institute appointed him as an *Institute Chair Professor* from 31st December 2009. He was re-employed by the Ministry of Human Resource Development (MHRD) of Government of India (GOI) for five years until 30 June 2016 though he formally retired (superannuated) from service on 30 June 2011. **The Institute honoured him with the title of *Professor Emeritus for life, an honour bestowed on a select few of the retired faculty*, on 27 September 2017.** Through an endowment of Rs. 1.15 crore created by his students and well-wishers in the industry, a *Prof. Tarun Kant Endowed Chair* was established in his honour in the department of civil engineering of IIT Bombay on 19th March 2020.

Prof. Kant was elected a *Fellow of the Indian National Academy of Engineering (INAE)* in 1999, a *Fellow of the Indian Academy of Sciences (IASc)* in 2004, a *Fellow of the Indian National Science Academy (INSA)* in 2007 and a *Fellow of the National Academy of Sciences, India (NASI)* in 2011. **He is the first civil engineering academic in the country to get elected to all the four national academies – one engineering (INAE) and three science (INSA, IASc and NASI).**

Prof. Kant was a *visiting scholar* at University of Wales, Swansea (1979-'82) and a *visiting professor* at University of Cambridge (1993) and University of California, Los Angeles (2005).

He is a recipient of the *Burmah-Shell Best Paper Prize*. He was the first engineer selected by a committee after personal interview whose chairperson was no less a person than the Prime Minister of India (Late Mr. Morarji Desai) and was awarded the *1979 Jawaharlal Nehru Memorial Trust (U.K) Scholarship* to carryout research in Finite Element Methods in the United Kingdom; he was also selected for the 1992-'93 *European Commission (EC) Senior Faculty Exchange Fellowship*, both by the Government of India. He was awarded the *2006 Professor H.H. Mathur Award for Excellence in Research in Applied Sciences* in recognition of his outstanding work in the area of Mechanics of Composite Materials and Structures by IIT Bombay on 13th March 2007. He also received the *2009 Khosla National Award for his lifetime achievement* in the field of engineering. He is also a recipient of the *2010 IIT Bombay Research Paper Award*. **He was conferred with the 2011 Lifetime Achievement Award of IIT Bombay on 4th April 2012.** ICCS17 (17th International Conference on Composite Structures, Porto, Portugal, 17-21 June 2013) honoured Professors Romesh Batra, JN Reddy and Kant with the title "**legends and pioneers in mechanics of composites**". Of course, being included in the same category as Professors Batra and Reddy was in itself a great honour for Prof. Kant. He received the *APACM Senior Scientist Award* of the Asia Pacific Association of Computational Mechanics (APACM) on 12th December 2013 during APCOM2013 in Singapore. Received the *ICES (International Conference on Computational and Experimental Engineering and Sciences) Lifetime Achievement Award - 2015 Medal* in Reno, Nevada, USA on 23rd July 2015 for making seminal contributions to composite materials and to the education of generations of students in India. Birla Institute of Technology & Science (BITS) Pilani also honoured him with *Lifetime Achievement Award* on 26th February 2018. He is also honoured with 2019 INSA's (Indian National Science Academy's) Prof Brahm Prakash Memorial Medal [Lecture was delivered on 15th September 2021 (Engineers' Day) at IIT Delhi where medal and citation were received] and 2020 Vasvik Award for Mechanical & Structural Science & Technology.

He has published 160 research papers in refereed journals, 6 chapters in edited books, about 182 papers in conference proceedings, edited 4 books and currently serves on the editorial boards of 5 international journals in diverse areas of computational structural mechanics. He has supervised 27 PhD and over 77 MTech and over 90 BTech students in their theses/ dissertations/ projects. He has also been a referee for over 100 external PhD theses. He has *Research & Citation Standing in terms of h-index of 47 on GoogleScholar (35 on Web of Science & 40 on Scopus)*. His current **citations are over 8289 on GoogleScholar** (over 4082 on Web of Science & 5113 on Scopus). He is in the top 0.3659% in the list of **Top 2% Global Scientists** published by Stanford University in November 2020.

He has carried out 12 sponsored projects and has authored about 21 unpublished reports. He has edited a set of two volumes entitled *Finite Elements in Computational Mechanics*, Pergamon Press, Oxford, 1985 (ISBN 0-08-031682-2), a special thematic issue on *Computational Mechanics* of the *Proceedings of the Indian National Science Academy (ProclNSA)* [Volume 82(2), June 2016, pp. 147-402] and has co-edited another volume entitled *Advances in Structural Engineering*, Quest Publications, Mumbai, 2000 (ISBN 81-87099-08-9).

He served a term on the editorial board of *Computational Mechanics – An International Journal* and currently serves on editorial boards of 5 international journals: *Structural Engineering & Mechanics - An International Journal* [Techno-Press, South Korea], *International Journal for Computational Methods in Engineering Science and Mechanics (CMESM)* [Taylor & Francis], *Computer Modeling in Engineering & Sciences (CMES)* [Tech Science Press], *Advances in Civil Engineering* [Hindawi Publishing Corp.] and *International Journal of Computational Methods* [World Scientific]. He was Editor of *Advances in Civil*

Engineering and Editor of Engineering & Technology Section of the Proceedings of the Indian National Science Academy (ProclNSA).

His sustained efforts for over 10 years resulted in establishment of an interdisciplinary research centre, *Centre for Computational Engineering and Science (CCES)* at IIT-Bombay [www.cces.iitb.ac.in] on 8th October 2018 with generous financial support from the Department of Atomic Energy (DAE) through Board of Research in Nuclear Sciences (BRNS). This unique facility is a kind of national facility; it's resources can be accessed through network from anywhere in the country. He has influenced many of his colleagues in several Institutes to contribute substantially to this area.

He was elected President of the Indian Society of Theoretical and Applied Mechanics (ISTAM) for two terms (1999 and 2000), **has founded *Indian Association for Computational Mechanics (IndACM)* and *Indian Association for Structural Engineering (IASE)* and is responsible for organization of biennial ICCMS (International Congress on Computational Mechanics and Simulation) and SEC (Structural Engineering Convention) congresses in the country very successfully.** Both these conferences are research oriented and has influenced many young researchers, mainly the PhD students of IITs, to do quality research and publish their research results in peer reviewed reputed journals. He was an INSA nominated Member on the National Committee of International Union of Theoretical & Applied Mechanics (IUTAM) for two, 3 year terms: July 2000-June 2003 and January 2008-December 2011. He was also a Member of the General Assembly of IUTAM until 2012. He was a Member of Engineering & Technology Sections of both INSA and IASc for several years and later also became their convenor. Presently, he is a Council Member of INSA for a three year term (2020-2022).

Besides his scholarly and notable scientific publications in computational solid mechanics, he has displayed leadership initiatives and has made long and sustained contributions in the field for over 50 years and is recognized as **"the face of India"** in computational mechanics. **He is also responsible for convincing a donor, Mr. Jitendra Mehta, a 1963 alumnus and a successful civil contractor in California, USA, for creation of the first endowed Chair in the department – the JK & MJ Mehta Chair.** He also mobilized more than Rs. 1.15 crore through small donations/ contributions from his former students (alumni), friends in the industry and his own personal funds for creation of **an unique endowed Chair in the department.** He has been honoured with several National and International awards for contributions to computational engineering, solid and structural mechanics and composites. Only and first Indian academician-scientist to have been invited to give a Semi-Plenary Talk at the world famous WCCM-APCOM (2016, Seoul, South Korea) international computational mechanics conference.

Through a *Technology Transfer* scheme of IIT Bombay, the outcome of his research on *Composite Mechanics* has been ported on PARAM systems of C-DAC Pune in the form of a computer code FEMCOMP which is being used by several organizations including IITs in the country and Russia.

He has been on the Advisory Panels of many national and international conferences. He has lectured at several universities and research institutions and has participated in numerous conferences and seminars both within and outside India. He was the Convener of a very successful International Conference on Finite Elements in Computational Mechanics held in 1985 (FEICOM-85) at Bombay. He was also General Chairman of SEC-2000: 2nd Structural Engineering Convention held on 5-8 January 2000 at IIT-Bombay and Chair of ICCMS09: 3rd International Congress on Computational Mechanics & Simulation held on 1-5 December 2009 at IIT-Bombay. He is listed in several Who's Who in the World.

He is a Fellow of The Institution of Engineers (IE) and The Aeronautical Society of India (AeSI), a Member of International Association for Computational Mechanics (IACM) and Life Members of The Indian Society

of Theoretical and Applied Mechanics (ISTAM) and Indian Society for Technical Education (ISTE) and Founder Life Member of International Society for Computational Engineering and Science (ISCES), Fellow of Indian Association for Computational Mechanics (IndACM) and Fellow of Indian Association for Structural Engineering (IASE). He is also a nominated Fellow of The World Innovation Foundation (U.K).

His research interests lie in the areas of solid mechanics, plates, shells, fibre reinforced polymer composites, refined higher-order theories, thermal stresses, transient dynamics, finite element and other numerical methods, use of polymer composites in construction, mechanics of composite materials and structures & computational mechanics.

He is a consultant to many leading government and private organizations and serves on many national and state research/ advisory/ policy/ selection committees and is a member of several national and international bodies.

Besides, being a Professor Emeritus (for life) at IIT Bombay, he is presently a Visiting Distinguished Professor at IIT Mandi and an Adjunct Professor at both IIT Indore and IIT Hyderabad.

Notable Contributions to IIT Bombay Society/Community at Large

His personal initiatives as a departmental faculty member led to the following:

1. Got fabricated strong & durable blocks (500 x 500 x 150) in M35 concrete in Heavy Structures' Lab to make an environmentally friendly pathway over the green lawn to connect the civil engineering corridor to the existing concrete roadway to avoid people going over the lawn in mud during monsoon.
2. The areas over two staircases in the department were open to sky. During monsoon the stairs' steps used to become wet and slippery. A number of students and staff members used to slip and get injured during monsoon. His personal initiative with the estate office led to the covering of the area with transparent corrugated fibre reinforced plastic sheets at the roof level. Other departments followed suit seeing this development in the civil engineering.
3. There were two toilet blocks on the ground floor near the stairs. Due to neglect and less usage by the department's staff and students, they were eyesores to any visitor to the department. Got them demolished during nineties with the support of then head of department and few faculty members. There were some opposition in the department due to now absence of no toilet blocks on the ground floor because a person on the ground floor had to climb up one floor up to use a toilet block. In the process also got a new unique central entrance to the department. Ultimately, this change gave a new neat and clean look to the department and everyone accepted it.
4. Looked after general cleanliness and upkeep, especially the hygiene in the toilets of the department as a social service for several decades until he finally retired on 30th June 2016 after a five-year term of re-employment by Gol.
5. He is singly responsible for bringing-in internet in the department through his individual initiative in getting modest hardware in place through an enthusiastic student, Amitey, of aerospace department. He was responsible for developing a modern and top class computer laboratory in the department, the only one in the Institute in nineties by enthusiastic participation of about 50

registered PhD students in the department at the time by maintaining a dust-free environment and keeping the computer laboratory open 24x7. Many students from other departments started making use of the facility in those days.

At the Institute level as Chairman of Central Library (1994-1999) and Dean-Planning (2001-2003) he showed his initiatives through dedication and hard work and introduced and carried out many innovations, some of which are listed below:

1. Almost immediately after I had taken over as Dean (Planning), on an evening I learnt that the Institute had won a case to evict a longtime encroacher who had a sizable amount of land behind C-Transit Building in the Institute in his possession since the Institute came in being in 1958. I decided to remain present on the site when the Executive Engineer (Estate) arrived along with his men on the site to demolish the old existing structure. I was told later by the Executive Engineer that my presence made a lot of difference to him and the Estate Office Staff who had arrived there and they could complete the job successfully without any resistance from the encroachers. The Estate Office was so elated that they could quickly close the broken boundary wall along the main Adi Sankaracharya Marg with stone masonry work within few hours.
2. On the advice of a Consulting Architect, my predecessor Dean (Planning) had redesigned parking lot, the associated traffic movement around the Y-Point Gate and making entry into the campus through a steep road. Unfortunately, it had turned out to be very complicated and circuitous. There were a lot of complaints, including in an Institute Faculty Meeting, from the residents /faculty of the campus/Institute. The first job that I did after taking over as Dean (Planning) was to straighten the road by dividing the parking lot into two parts and reducing the steep slope of the road. People inside the campus felt a lot of relief after these simple common changes.
3. Introduced communication within and outside through internet e-mail facility in the Library. Though, IITB budget for library was quite good but still because of high cost of subscription of foreign journals, it was not possible to procure all the necessary journals in the Central Library for the benefit of research students and faculty. He rationalized the subscription of journals by various departments and research groups in the Institute through persuasion and communication, for the first time, by formal meetings of Librarians and Directors of all IITs and BARC which led to a written, workable and functional MoU for providing xerox copies of journal papers required by a user within a week in the consortium of IITs and BARC. This initiative worked very well for several years benefitting all at no extra cost till the Ministry of Human Resource Development (MHRD), formed a consortium, of all higher educational institutions for centralized procurement of journals.
4. He introduced, for the first time in the country, submission of electronic version (.pdf copies) of PhD theses and MTech dissertations to Central Library for archival purpose by the graduating students themselves, at no extra cost to the Institute, through a well-defined procedure by presenting his proposal to the Institute Senate. In this entire process the then Director Prof Suhas P Sukhatme played a very positive encouraging role.
5. When he took over as Dean-Planning in December 2001, the planning of Hostels 12 & 13, of about 1000 plus single seated rooms, was on the drawing board and was awarded to Larsen & Toubro Construction Company as a turnkey project, for the first time, as an experiment. This was necessitated due to acute shortage of hostel accommodation for students. Right from the start of the construction, a number of objections/ stop-work notices were received from the Municipal

Corporation of Greater Mumbai (MCGM) due to shoddy approvals of Architect M/s Hafeez Contractor and non-involvement of our estate engineers in the matter. He had to get these objections overruled through urban development department of the Government of Maharashtra (GoM) and at MCGM Municipal Commissioner's level through his personal contacts/ friends in GoM. He never brought these issues to the notice of his Director because he always felt that having taken the responsibility of the position of Dean-Planning it was his duty and responsibility to resolve these issues at his level. This megaproject of two big hostels of the size never taken in the Institute before along with creating a dining facility of 1000 + 1000 students at a time was a big challenge and to the surprise of everybody it could be completed in a record time of 18 months from the date of the issue of the contract.

6. IIT Bombay campus had hardly had any footpath in existence. During summer of 2002, he visited USA to attend a conference. He took the opportunity of visiting his son for a week who was then in San Diego, California. He started going out for his morning walks on the footpaths along the roads there. He was impressed by the simple and neat construction of footpaths in white cement concrete there. On return from there, he asked the Executive Engineer (Estate) of IIT Bombay Mr Vivek B Mamdapur and his assistant Mr Unnithan to let him know the possible length of footpaths in the campus if one goes for constructing these. They asked him if they could also include the open storm water drains along the road sides which existed then. His response was yes, if they could only design proper prefab covers so that people could walk on it without tripping. The estimated length came out to be about 20 Kms. It was decided to have a standard cross-section of 1500x150 for most of the footpaths except the one from the main building to Hostels 12 & 13 to have a cross-section of 2000x150, all in M25 cement concrete with broom finished top surface, so that students in groups could walk safely and freely on it. It was decided to tender the entire lot in three segments so as to ensure that the three contractors complete the job simultaneously in a record time of about 12 months. Road widening across the campus was also undertaken along with footpath construction. These footpaths turned to be not only safe for walking but have also turned out to be durable that even after more than twenty years they are intact. Incidentally, it was tried to propagate the same model for MCGM and MMRDA by persuading their engineers to follow and implement but have failed. They have continued with their interlocking concrete blocks/ tiled surface footpaths which no sooner are they built their blocks/ tiles start coming out making the top surface unfit for safe walk or a safe wheel chair movement. Their engineers have their own interest in mass demolition and reconstruction year after year without worrying about waste of public money.
7. There used to be scarcity of water during summer months for gardening. The water from the two abandoned wells, one behind CTR building and the other near the Staff Club, were made use of for this purpose.
8. Lecture Theatre (LT), now called the PC Saxena Auditorium (PCSA) having a seating capacity of about 250, is an important place for meeting of all kinds – academic, social, conferences, etc. In the past its false ceiling had been seen falling down every now and then. One day a proposal from the executive engineer (estate) was received for approval by the Dean-Planning for bituminous waterproofing of its roof estimated to cost about 3.00 lakh. Instead of approving it, the Dean-Planning wrote on it "Please speak to me" and sent it back. When Executive Engineer Mr Mamdapur came to speak he was asked "how often do you go for waterproofing"? His response was "every two years or so" . I asked him to wait for some time. I asked Mr RN Mukherjee, a retired Chief Engineer from Atomic Energy Commission who was hired temporarily to look after the construction of Hostels 12 & 13 to get a rough design and drawing of a corrugated aluminum sheet roof over it with light steel frame support system over the existing roof of the

PCSA through the engineering staff of the local L & T site office. He brought a drawing after about a week. It was okay but did not give good look. In the meantime, Mr Hafeez Contractor visited me in connection the Hostels 12 & 13. I requested him if his architectural firm could provide a good aesthetic shape to the aluminum sheeting roof. He sent me after a few days a modified good looking curved surface shape. I froze it and asked Mr Mamdapur to go for it (a roof over roof concept). We got a contractor through open tendering who agreed to do it as a turn key project for a sum of Rs. 17.00 lakh. Fortunately, this experiment turned out to be very successful and the roof is still intact without any maintenance even after 21 years (now in 2021) and keeping the fully furnished PCSA in safe and good condition.

9. The new building of the Department of Aerospace Engineering (DAE) which came up around 1980 when there was an acute shortage of cement and the state's Chief Minister was one Barrister, Mr Antulay. The initial structural construction of this building is very bad. It started showing signs of distress just after it was constructed. The building has a large number reinforced concrete beams of about 40 feet span and depth of about 1.0 meter. Extensive cracks were seen in these beams and concrete had started falling on the floor. External Consultants suggested repairs with either polymer modified mortar (PMM) or attachment of a 4 mm thick steel plate with polymer in the tensile zone at the bottom face of the beam. Both these solutions were very expensive. Fixing a steel plate was in fact tried out but after some time it was seen to delaminate. Estate office was busy finding a durable solution. The issue of repairs of these beams was brought out before me while I was the Dean-Planning. I was aware of the problem because of my very close association with the DAE. I had suggested some repairs with simple mix of 1:2:4 with small size aggregates in the past in NITIE in repairs of their buildings and that had turned out to be simple, inexpensive and durable. The reason for suggesting 1:2:4 mix was that because the original concrete used was of the same mix. Luckily, the main reinforcement in the beams had not corroded at all. They were all mild steel bars. I requested my colleague in the department, Prof Yogesh Desai to help me out in this project. The main reinforcements were found to be adequate in the existing structure by design. The quality of concrete was bad. We suggested a solution which was not only inexpensive and simple but which also turned out to be durable. The original concrete used was M15 (1:2:4 by simple proportion by volume of cement: sand: aggregate). We suggested that all the loose concrete be removed from all the three faces of the beams and replaced with mortar of the same mix but with small size, < 20 mm, aggregates. All the beams that were repaired with the above methodology did not require any further repairs even after 20 years (2021) and the DAE was rehabilitated satisfactorily.
10. On a field visit with the Institute executive engineer (estate) and his staff, I as Dean-Planning found that the area lying between the guest house and the main road was kept in a very untidy condition. The land was undulated with full of shrubs and pond was very dirty and shallow. I asked the staff to get the pond desilted and the shores paved with natural stones and get the entire area cleaned up and leveled. The open area automatically got converted into **Guest House Lawn** with very good natural ambience. I, as Dean-Planning, requested Mr Mamdapur, sometime in November 2002, who was the Social/General Secretary of the Staff Club, to host the Annual Staff Club Dinner Night in the lawn and we introduced this new facility to the campus community. This place now remains in great demand for functions with catering facility for large gatherings like conferences and marriages. This community facility fetches a decent sum of money to the Institute.
11. The open area in front of the White House building and abutting Powai Lake fringe road had remained undeveloped until middle of 2001 although White House came up in around 1984. The desilting of the pond in front of the Guest House was a blessing in disguise. The silt from the

pond was dumped here to level the area and with the help of Estate Officer Mr Mamdapur we got the entire place converted into a beautiful **Sarovar Udyan** by constructing a jogging track, carving out a children's playing area with modest facility and a small garden.

12. The open area between CTR building and the old multistorey building had a diagonal storm water drainage line coming from outside the Institute boundary in from of the HP Petrol Pump making the entire area unusable for anything useful. I, as Dean-Planning, got the outside drain along the road connected to another existing storm water drain beyond the Old Multistorey Building, making the large parcel of area useful. It is a pity that it is still lying unutilized. If I had continued as Dean-Planning and had not resigned about one year before my term was to end, then I would have got this beautiful piece of land converted into a much more beautiful garden for the residents of the campus to enjoy.
13. There existed only one sewage water pumping station behind Hostel-8 from where it used to be lifted and drawn into the far off main municipal drainage line near Y-point. This pumping station was under tremendous stress and there have been instances of overflowing sewage especially within the Staff Club premises and along the lake fringe road near the guest house. Based on the topography of the drainage lines and after a thorough study, I, as Dean-Planning, took a decision to install a second pumping station in the lake side area and discharge the sewage directly to the nearby municipal line running along the Adi Sankaracharya Marg. This timely action helped in reducing the excessive pressure on the old pumping station behind Hostel-8 and situation improved considerably.
14. Like shortage of hostel rooms for students, the Institute also realized that it lacked faculty housing for the expanding institute. I along with the chosen Architect and the Estate Engineer Mr Mamdapur surveyed the entire institute land for the new housing complexes. To our surprise we found that there was hardly any space available for a large 60 B-type housing complex unless we chose to go for vertical development. By year 2000, the Institute had already given away about 110 acres to NITIE and another very significant and important land pieces in recent years to SAMEER and Kendriya Vidyalaya, there was hardly anything left for future development of the Institute unless we decided to go on the other side of the pipeline and reclaim our land from the encroachers. We managed to locate two parcels of land, one between Vidya Niwas and SAMEER and the other on the hilltop behind Tulsi apartments and two C-type multistorey buildings on the hill side. We decided to construct 60 flats in a building, first of its kind in the campus, with stilt plus 16 upper floors, one floor reserved as a refuse one and each floor having 4 flats of about 1200 sft carpet area each. M/s Hafeez Contractor presented to us 3-4 internal layout of the flats but none of our liking. In the mean time I happened to visit my niece in Pune and I liked the internal layout of their flat. On return from there, I passed on a sketch of the internal layout of flat that I had seen in Pune to the Architect. M/s Hafeez Contractor came up with a revised layout based on the sketch and it was liked by our internal committee that we had formed for this building. And finally the design of the entire building was frozen after getting feedback from the campus community. Lumpsum tenders along with market rates for the item (a lesson learnt from Hostels 12 & 13 contract which had no rates of the items) were invited and the contract was awarded to M/s Larsen & Toubro and the construction started in the second half of 2002. I took part in the Bhoomi Pujan function and continued to look after this construction until foundation work was completed. We had to get one footing demolished completely because of the poor quality of RMC that was used for its construction. I feel sad that I could not see the completion of this project, though I conceived, planned and started it from scratch, because I resigned from the deanship in December 2002 due to a conflict with the then Director.

15. Renovation, expansion and redesigning of eating halls of mess and kitchen areas of Hostels - 6, 7, 10, etc., necessitated by increased students' strength, had been done before I took over as Dean (Planning) by employing Architect Mr. Hafeez Contractor. However, we found that the experience of students and mess staff after these renovations, was not very good. Similar renovation, alteration of mess, kitchen, complete re-casting of roofs of kitchen areas of especially Hostels 9 and 11 due to their deterioration beyond repairs, expansion and construction of additional recreational facilities were required in several other hostels. We decided to take-up these works without employing external Architect and Consulting Engineers. I, as Dean (Planning) took the Estate Office in confidence. With the help of a Hostel Mess Renovation Coordination Team ably led by Prof. S.S. Major of Physics Department and full involvement of the estate office led by Executive Engineer Mr V.B. Mamdapur, the mammoth work of planning, design, drawing, construction, finishing and execution could be taken up in one go totally internally without the involvement of an external Architect and Consulting Engineer, at a cost of about 5.00 Crore, for Hostels 1, 2, 3, 4, 5, 9 and 11 for the first time in the history of IITB through civil contractor M/s Larsen & Toubro, who were already present in the campus and were winding up their set-up after completion of two new Hostels 12 and 13. This successful completion of a mammoth job instilled a lot of confidence in the engineering staff of the estate office of the Institute who were until then involved with only maintenance jobs..
16. The upkeep and maintenance of Institute buildings including housekeeping was not at all satisfactory before I took over as Dean (Planning). I impressed upon the Public Health Officer, Mr. Bhagwan Patil, to employ several dedicated house-keeping agencies, through open tenders, for different buildings with emphasis on total cleanliness and hygiene of entire premises with extra emphasis on toilet blocks' cleaning. The system has succeeded and is continuing even today after a period of over two decades. However it needs proper supervision and monitoring and finally evaluation.
17. For speedy, quality, economical and durable civil maintenance works in academic, residential and hostel areas, enlistment of good contractors for Annual Maintenance Contract by constituting a Task Force of experienced faculty members of the department of civil engineering, though an experiment, was successful.

All the above could be achieved by involving all the stake holders - the Institute functionaries, Heads of Departments, Hostel Wardens, Estate Office led by Mr. V.B. Mamdapur, Public Health Office led by Mr. Bhagwan Patil, Electrical Maintenance Division led by Mr. Subbiah, departmental esteemed colleagues and others in the campus and creating an environment of mutual cooperation and trust.

Research Contributions of Professor Tarun Kant of IIT Bombay

Professor Kant developed interest in computational methods of structural analysis and theories of plates and shells during his Master's study at IIT Kanpur during 1967-'69. His MTech dissertation, which tackled clamped-clamped and clamped-simply supported boundary conditions over curved edges and free conditions over the longitudinal edges of a single and multi-barrel cylindrical shell, quite effectively encouraged him to write his first technical paper and publish which also earned him an award.

Professor Kant was quite ahead of his time when he chose the difficult topic of elastic shells and initiated research on two dimensional (2D) higher order theories for predicting realistic behavior of thick three dimensional (3D) physical shells discarding most of the assumptions in the classical Love shell theory [Ref. Kant, T. (1976), *Thick Shells of Revolution-Some Studies*. Ph.D. Thesis, Indian Institute of Technology Bombay; Kant, T. and

Ramesh, C.K. (1976), *Analysis of thick orthotropic shells*, in *Proc. IASS World Congress on Space Enclosures, Montreal, Canada, 4-9 July*, pp. 401-409]. During the course of this study, for practical analysis, he developed and perfected a numerical integration (NI) technique involving the so-called *segmentation* which could capture the boundary layer effects inherent in the shell equations [Ref. Kant, T. and Ramesh, C.K. (1981), *Numerical integration of linear boundary value problems in solid mechanics by segmentation method*, *International Journal for Numerical Methods in Engineering* **17**, 1233-1256]. Later, he improved on his earlier work and extended it to include composite materials by improving the fundamental deformation models [Ref. Kant, T. (1981), *A higher-order general shell theory*, Rep. C/R/391/81, University of Wales, Swansea; Kant, T. (1981), *A higher-order general laminated shell theory*, Rep. C/R/395/81, University of Wales, Swansea]. These developments were not only significant but are now regarded as pioneering works in the then nascent area of higher order theories of elastic beams, arches, plates and shells – a renaissance, a new beginning in the development and more important, the quantification of the improved response behaviour in the structural elements with higher-order theories.

One of his PhD thesis examiners, Dr. MVV Murthy [of National Aerospace Laboratories (NAL) Bengaluru] got so much influenced by the work that later, as a NASA Fellow, at the NASA Langley Research Centre, wrote a technical note on composite plates that became a forerunner for future research in the area. Later, Prof. Kant got interested in the mechanics of multilayered fibre reinforced polymer composites (FRPCs) and finite element (FE) modelling. A laminate is a multilayered composite made up of several individual layers (laminae), in each of which the fibres are oriented in a predetermined direction to provide efficiently the required strength and stiffness parameters. Development of two dimensional (2D) accurate plate/ shell analytical models, of these physically three dimensional (3D) laminates, has been an area of active research since early 1960s. Prof. Kant has made significant pioneering contributions to the mechanics of FRPCs which has led to better understanding of their behaviour. Realizing the importance of application of these new materials in high technology areas, he initiated a systematic research effort, way back in the year 1980, towards development of both continuum and discrete FE higher order deformation models for improved response characteristics of the laminates in the form of beams, plates and shells. He was the first to derive the consistent mathematical model, based on a displacement based variational principle, for a C^0 higher order plate theory [Kant, T. (1982), *Numerical analysis of thick plates*, *Computer Methods in Applied Mechanics and Engineering* **31**, 1-18]. These efforts were initially directed towards construction of simple C^0 FEs for applications to real life problems. His demonstration of C^0 FE formulation of higher order displacement theories is considered as a pioneering work by his peers and is now being extensively used [Kant, T., Owen, D.R.J. and Zienkiewicz, O.C. (1982), *A refined higher-order C^0 plate bending element*, *Computers and Structures* **15**, 177-183]. He and his co-workers have clearly demonstrated the application of these analytical and computational models to a variety of problems in structural engineering. **He also busted a myth prevalent around the so-called a parallel C^1 formulation for plates in which the free surface conditions are additionally enforced by numerically showing that their C^0 formulation produced most accurate results for displacements and stresses** [Kant, T. and Swaminathan, K. (2002), *Analytical solutions for the static analysis of laminated composite and sandwich plates based on a higher order refined theory*, *Composite Structures* **56**, 329-344]. The accuracy of their C^0 model over C^1 model has also been independently confirmed [Ref. Rohwer, K. (1992), *Application of higher order theories to the bending analysis of layered composite plates*, *International Journal of Solids and Structures* **29**, 105-119; Rohwer, K. and Rolfes, R. (2004), *Stress analysis of laminated structures from fiber-reinforced composite materials*, *Proc. International Congress on Computational Mechanics and Simulation 2004 (ICCMS2004)*, Vol. 1, IIT Kanpur, 21-42]

Most plate/shell theory solutions in neighbourhood of the boundary are very sensitive to boundary conditions; the solutions vary sharply in the edge zones. This is called boundary layer effect which is present in the solutions of the exact 3D formulations and thus it is a reality. Unfortunately, FE method was not suitable for capturing such steep stress gradients while the experience with the NI technique for such evaluations was extremely encouraging. **Recently, Prof. Kant and his associates have shown, for the first time, the effectiveness of a new partial/semi discretization methodology through marriage of FE and NI approaches** specifically for evaluation of interlaminar stresses in layered composites **and in general indeed an unique semi discretization method, for equilibrium problems** [Kant, T., Pendhari, S.S. and Desai, Y.M. (2007), *A general partial discretization methodology for interlaminar stress computation in composite laminates*, *Computer Modeling in Engineering & Science* **17**(2), 135-161].

The papers written by Prof. Kant and his associates give not only the mathematical models but also describe the powerful FE computational models as well as the analytical methods for the thermo-mechanical-piezoelectric behaviour of fibre reinforced composite/ functionally graded laminates used in the form of beams, arches, plates and shells for the three types of analyses, i.e., equilibrium, eigenvalue and transient, encountered in practice and in a significant way, highlight the research contributions made to the scientific literature by Professor Tarun Kant and his associates.

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Professor Tarun Kant

Awards and Recognitions

- | | | |
|-------|---|------------------------------|
| 1975: | Burmah-Shell Best Paper Prize by The Aeronautical Society of India. | --National |
| 1979: | Jawaharlal Nehru Memorial Trust (UK) Scholarship by the Government of India. | --National/
International |
| 1993: | European Commission (EC) Senior Faculty Exchange Fellowship by the Government of India. | --National/
International |
| 1995: | PARAM Second Prize award in the category of scientific & engineering applications | |

	by the C-DAC Awards Committee for the work entitled Parallel Finite Element Based Composite Analysis Package on PARAM.	--National
1999:	Elected a Fellow of the Indian National Academy of Engineering (INAE).	--National
2004:	Elected a Fellow of the Indian Academy of Sciences (IASc).	--National
2007:	IIT Bombay conferred the 2006 Professor HH Mathur Award for excellence in research in applied sciences in recognition of his outstanding work in the area of mechanics of composite materials and structures.	--National
2007:	Elected a Fellow of the Indian National Science Academy (INSA).	--National
2009:	Khosla National Award for his life time achievement in the field of engineering by the Indian Institute of Technology Roorkee.	--National
2010:	IIT Bombay research paper award.	--National
2011:	Elected a Fellow of the National Academy of Sciences, India (NASI)	--National
2012:	IIT Bombay conferred the 2011 Life Time Achievement Award.	--National
2013:	ICCS17 (17 th International Conference on Composite Structures, Porto, Portugal, 17-21 June 2013) honoured him with a <i>title legend</i> and recognized him as a pioneer in initiating a new direction in mechanics of composites.	--International
2013:	Received <i>APACM Senior Scientist Award</i> of the Asia Pacific Association of Computational Mechanics (APACM): awarded on 12 December 2013 during APCOM2013 in Singapore.	--International
2015:	ICCES (International Conference on Computational and Experimental Engineering and Sciences) awarded the Lifetime Achievement Award Medal – 2015 in Reno, Nevada, USA on 23 July 2015 for making seminal contributions to composite materials and to the education of generations of students in India.	--International
2017:	IIT Bombay honoured him with the title of Professor Emeritus on 27 Sept. 2017	--National
2018:	Birla Institute of Technology & Science, Pilani honoured him with Life time achievement award on 26 February 2018	-National
2019:	INSA <i>Professor Brahm Prakash Memorial Medal 2019</i> [Lecture was delivered on 15 th September 2021 at IIT Delhi where medal and citation were received]	-National
2020:	<i>Prof Tarun Kant Endowed Chair Professorship</i> was established in department of civil engineering of IIT Bombay on 19 th March 2020	- National
2020:	Placed at Rank No. 651 in the top 0.3659% globally in the research field of "materials" in the list of Top 2% global scientists in various fields published by Stanford University in November 2020.	-- International
2021:	Vasvik Award for Mechanical & Structural Science & Technology for the year 2020	- National