Prof Johan Retief: a career built around risk and reliability

Caption: *Prof Johan Retief received a DEng degree in 2015 from Stellenbosch University (SU). Present at the function were prof. Celeste Viljoen, today vice dean: teaching and learning of the SU Faculty of Engineering, and Prof Gideon van Zijl, today a professor in Civil Engineering at SU.*

Some two decades after retiring from the Department of Civil Engineering at Stellenbosch University (SU), Emeritus Professor Johan Retief still contemplates the philosophy of engineering and the potential impact of wind on structural design, given future climate change scenarios. These ideas are born from the many years he spent studying the principles and standards of reliable and affordable civil engineered structures.

His career spans two clearly defined periods. From the 1960s to 1990 Prof Retief worked for South Africa's former Atomic Energy Corporation (AEC), followed by his "second career", as professor and researcher in the SU Department of Civil Engineering. This Fellow of the South African Institute for Civil Engineering retired in 2001 but remains actively involved in related projects.

Prof Retief summarises his chosen research field as such: "Reliability is about the probability that a structure could fail, while risk is about the consequences of such an event. Probability times the consequences represent the expected risk, to be accounted for in optimized design of structures.

"It isn't enough to use experience-based judgement when designing structures. Engineers must consider the uncertainties of structural mechanics and mathematical models when they for instance introduce new techniques, designs, skills, or materials, or want to improve on existing practice. It must be modelled probabilistically for rational decision-making and design of safe structures," he notes.

AEC years

Prof Retief, who grew in the Rustenburg district, received his BScEng degree in Civil Engineering from the University of Pretoria (UP) in 1962. After a short stint at the then Department of Water Affairs, many productive years at the Atomic Energy Board (AEB, later known as the AEC) followed, during which he was afforded the opportunity to study abroad. In 1967 he completed a diploma (DIC) in reactor engineering from Imperial College and an MPhil from London University in civil engineering, and in 1971 a postgraduate qualification in nuclear civil engineering (1971) from Stanford University. In 1987 his work on structural and site safety at nuclear installations led to a DSc in Engineering from UP, for research on the building of test facilities for planned reactor systems.

Between 1983 and 1990 Prof Retief served as manager of the AEB's Department of Nuclear Engineering. During this period, he was responsible for the civil works for a planned nuclear reactor research site at Gouriqua near Mossel Bay.

"My small multi-disciplinary team of engineers and scientists among others did site surveys and characterised the area. We studied aspects of coastal engineering and the environment around the terrain, and began planning for construction and management of the site," he remembers.

The Gouriqua project was cancelled in 1990 because of international pressure around South Africa's nuclear programme. The terrain was later developed into a nature reserve.

SU professor

Following his appointment as professor at SU in 1991, Prof Retief served as director of the Institute for Structural Engineering (ISE) between 1991 and 2002, and as chair of the Department of Civil Engineering between 1996 and 1997.

His industry-specific experience allowed him to extend a postgraduate course on risk and reliability that was previously presented by guest lecturers into a fully-fledged research programme. It tied in well with other research activities around structural and civil engineering and strengthened the Department's interaction with industry and international collaborators.

In 1997 Prof Retief and colleague Prof Peter Dunaiski established the Centre for the Development of Steel Structures (CDSS) together within the ISE. This move allowed for targeted, industry related research and postgraduate studies, including PhD research, with a focus on steel and structural engineering, together with applied structural reliability.

His subsequent research is encapsulated in more than 110 journal articles and conference presentations, as compiled into a dissertation for which he received the DEng degree in 2015 from SU. As study leader he supervised nine MEng students, 10 PhD students and another three DEng candidates. They worked on topics ranging from the application of risk and reliability in the construction of concrete and steel structures, engineering management and geotechnics to wind engineering and dam safety**.**

According to Prof Retief, he gains immense satisfaction from following his students' successes and awards, and from seeing how they have since taken up leadership positions in industry and academia. He also cherishes the opportunity to have been part of the evolution of the Department and Division of Structural Engineering, from entities largely focused on undergraduate training to ones that provide "a more integrated programme that also includes research and specialist services to the profession."

"The integrated research programme in the Division was followed by a host of innovative programmes in structural concrete, civil engineering informatics, and structural fire engineering," he remembers.

Loading codes

Members of the CDSS, under leadership of Prof Dunaiski, played a central role in a working group set up by the South African Institute of Civil Engineering in 1999. Its mandate was to revise SABS 0160-1989 into SANS 10160-2010 (also known as the South African Loading Code).

Prof Retief took the lead to set the overarching standard for the basis of design (Section 1), in which separate standards around actions or loads on a structure (Section 2 to 8) and the necessary resistance capacity were integrated through reliability calibrations. CDSS members completed the underlying background studies that the revision committee eventually based its recommendations on. In 2010, Proff Retief and Dunaiski published a background report on these studies.

“Major issues were identified and then tackled through our research programme. Technical assistance was given with formalising and managing these standards, as by helping with editing. We established networks with international colleagues working on similar issues, notably European colleagues who were involved in the parallel development of Eurocode. The circle of activities was completed by presenting induction courses during the transition and application of the new standards in structural design practice,” he remembers.

Since the publication of the South African Loading Code Prof Retief was also involved in the subsequent revision of material-based design standards for concrete, steel, water retaining structures, bridges and geotechnical structures. In this regard SU academics such as Proff Jan Wium, Celeste Viljoen, Peter Day and Dr Hennie de Clercq have played a leading role over recent decades.

As member of the national standards committee SABS TC 59-1 Basis of Structural Design and Actions Prof Retief represented South Africa between 2005 and 2017 as specialist delegate to the ISO TC 98 committee. Its mandate was to consider the basis for the design and actions on structures on behalf of the International Standards Organisation (ISO). He was a member of the working group that set principles of structural reliability, as incorporated into the leading ISO 2394-2015 standard, convenor of the ISO 22111-2019 working group that applied these principles, and member of the joint international committee on structural safety (JCSS). He was invited as observer to the Eurocode CEN TC 250 Sub-committee 1 responsible for the head standard on the basis of design and actions of the current generation of Eurocode standards on structural design.

“Considerations about risk and reliability is like the nervous system of structural and civil engineering. Being involved as such allowed me to work with colleagues across the Department who were the experts in their respective fields. Through the ISO platform I was able to on a national and international level compare South African practice with that of leading countries such as the USA, the UK (on which our local structural standards were previously based), Japan, Australia and various European countries. Research projects, seminars, and exchange visits to these countries were a consequence of these endeavours,” says Prof Retief.

Climate change

Prof Retief’s interest in the impact of climate change gained momentum in the early 2000s, after he was already officially retired, when SU and the Technical University of Regensburg in Germany joined forces to work on related projects.

He believes that current civil engineering reliability models do not as yet comprehensively take the potential impact of climate change on structures into account.

“Decisions are made today about structures that will for at least the next 50 years, even more, be exposed to the still uncertain effects of climate change. Considerations about the known trajectory of climate change, and the uncertainties around projected wind load conditions, must be accounted for in these decisions,” he notes.

“I believe the only way to make a dent in this wide field is to concentrate on the specific influence that changes in the extreme wind climate could have on building designs. This ties into my general interests into climate matters, including paleoclimate, as well as more far-reaching considerations about cosmology and our place in the Universe.”

Engineering philosophy

Now well into his eighties, Prof Retief still enjoys contemplating matters about the principles of engineering that should provide guidance on new challenges.

“Since engineering is concerned with the application of sciences, the logical position is to associate engineering principles with the fundamental philosophy of science” he says.

“I previously held the belief that engineers quite pragmatically corrupt the puristic science philosophy that searches for an objective truth, in an effort to come up with practical solutions. However, although scientific knowledge has brought us to the point of realising that humankind represents an awareness of the cosmos of itself, it also reveals we are in a process of impacting on the cosmos in what we do. This implies that the application of knowledge about the cosmos to be at a more fundamental philosophical level than the mere pursuit of knowledge.

“This is the fundamental philosophy that as an engineer I now identify myself with. How this is applied in terms of future challenges is vital.”