



Biography of Bernhard A. Schrefler

Youth and Early Career

Bernhard Aribio Schrefler was born in Merano in Southtirol (Italy) in 1942. He was brought up speaking both German and Italian. He attended a Technical High School in Bolzano, finishing in 1962. During this period, he developed his passion for mountaineering and climbing. He became member of the mountain rescue team and of the elite section (Hochtourengruppe) of the Alpine Club of South Tirol. Subsequently, he authored a successful hiker's guide "*Hiking Paradise Meran*", which reached five editions. During the last year of the High School he was the winner of his region in a Europe-wide competition for an essay on United Europe. With this came in September 1962 an eight-day trip with awardees from other regions, to cities in Northern Italy. In 1962 he enrolled for engineering studies at the University of Padua, where he obtained in 1967 his Master degree (laurea in ingegneria) with summa cum laude. The topic of his master thesis was "*Calculation of general type reinforcing systems for tall buildings*" and resulted in two papers published in 1970 and 1971. This method was incorporated in 1978 by RIB Software (Stuttgart), in "HOCHHAUS-KERN", a code for high rise buildings, and the authorship of the method was duly acknowledged. After his Master degree, he served fifteen months of military service in the Italian Air Force, and worked in a company designing cableways in the Alps for 6 months. In 1969 he returned to the University of Padua as Assistant Professor. He became lecturer in 1973 and full professor for Structural Mechanics at the Faculty of Engineering of the University of Padua in 1980.

Research Activity

Following a failure of a cable stayed pipeline bridge over the Po river during testing, he was able to explain and model this failure as an interaction between a bifurcation and a snap through instability, using the René Thom's Theory of Catastrophe (cusp catastrophe). This work was listed in 1980 and 1981 by E.C. Zeemann, a British Mathematician, in his "*Bibliography on Catastrophe Theory*". In 1975 Schrefler started his research on the subsidence of Venice, and went to the University College of Swansea (Wales), where he applied for the first time the theory of Biot (interaction between a solid phase and a fluid phase in a deforming porous medium) to subsidence modelling, working with Professors Roland Lewis and Olgierd C. Zienkiewicz (one of the three fathers of the Finite Element Method). This was the first of his many subsequent stays in Swansea. During this period, he extended Biot's theory to partially saturated soils, having in mind the subsidence above gas reservoirs—in particular in the Upper Adriatic Sea, and non-isothermal consolidation (sinking of the geothermal field of Abano, Italy). Since there were no doctoral schools in Italy at that time, in 1979 he applied for part time Ph.D. studies at the University College of Swansea, and completed his Ph.D. in 1984 with a thesis on "*The Finite Element Method in Soil Consolidation (with Application to Surface Subsidence)*". In 1992 he obtained a D.Sc. degree from the University of Wales.

The Ph.D. thesis became the book "*The Finite Element Method in the deformation and consolidation of porous Media*", Wiley, 1987, with R.W. Lewis as co-author. Together with the expanded second

edition of 1998, they are considered worldwide as state of the art works on these topics, and have received a total of 2238 citations according to Google Scholar. In 1999 he published with Professor Zienkiewicz, AHC. Chan, M. Pastor, and T. Shiomi, the book titled “*Computational Geomechanics with application to earthquake engineering* (858 cites). This book is now being translated to Chinese. Dr. Schrefler was the first to extend Biot’s theory to two- and three phase flows, and to introduce in 1982 the generalized Bishop’s stress, also called Lewis-Schrefler split, which is today’s most used stress tensor in partially saturated soil mechanics.

He has also addressed non isothermal elastic plastic consolidation, infinite elements in isothermal and non-isothermal consolidation, large strain quasi-static and dynamic partially saturated soil behaviour, strain localization in fully and partially saturated soils, constitutive modelling for partially saturated soils, thermo-hydro-mechanical analysis of partially saturated porous media, carbonation of concrete, three-fluids model for concrete with applications to concrete under very high temperatures, concrete at early ages, Alkali-Aggregate reactions and non-isothermal leaching. The concrete model, which is probably the most advanced general model, has been incorporated into several general-purpose computer programs: the high temperature part of the three-fluids model is implemented in CAST3M (CEA), CESAR (LCPC), HITECOSP (ENEA) with a patent, SYMPHONIE (CSTB) and concrete at early ages and beyond is implemented in LUSAS (UK) and in CAST3M (code of the French Atomic Energy Commission). The code HITECOSP, together with a Fire Dynamics Simulator is currently used for the safety and passenger comfort analysis for the Brenner Base Tunnel between Austria and Italy, one of the longest railway tunnels (55 km) under construction in the Alps.

In 2003, Schrefler realized that crack tip advancement in hydraulic fracturing is not smooth, but stepwise with pressure oscillations. This fact was unknown in the mechanics community where analytical and numerical solutions featured smooth behaviour. Subsequently he was able to explain this behaviour by invoking self-organization of rupture.

In the 80’s, Schrefler became involved in the design of a device for studying Thermonuclear Controlled Fusion, called Reversed Field Pinch (RFX), still operating at the University of Padua. He designed coils, vacuum chamber, including the carbon tiles. He was then involved in the design of NET (Next European Torus), which was never built because it was superseded by ITER (International Thermonuclear Experimental Reactor) currently under construction in Cadarache, France and already half completed. In this instance he dealt with superconducting coils through a multiscale and multiphase model, which allowed very accurate predictions of the residual strains after cool-down.

In 2011 he started a new topic, tumor growth and drug delivery models to evaluate the efficacy of anti-cancer drugs, including those carried by nanoparticles. This model is based on three phase flows in a deforming porous extracellular matrix, and diffusion-advection equations for transported substances by the neo-vasculature and the interstitial fluid in the tumor microenvironment.

The model is now coupled with a bio-distribution model to be able to simulate a tumor growth in a full patient specific organ and include drug delivery. For this endeavour Schrefler spent yearly periods at the Houston Methodist Research Institute (HMRI), Houston, Texas, as Senior Affiliated Scientist and more recently at the Institute for Advanced Study (IAS) of the Technical University of Munich as Hans Fischer Senior Fellow.

In 2013, Schrefler retired from University of Padua and was then nominated Professor Emeritus. He continues research at IAS and HMRI.

Service to the Scientific Community and Commissions of Trust

Dr. Schrefler has and still serves the scientific community extensively. Since 2001 he is Secretary General of the International Centre for Mechanical Sciences in Udine, Italy, the worldwide best known post-doc school for Mechanical Sciences. He is past chairman of the Italian Association of Computational Mechanics (GIMC, 1996-2000), past member of the Executive Council of the

International Association for Computational Mechanics (IACM, 2000-2012), past member of the Executive Committee of the Congress Committee of the International Union for Theoretical and Applied Mechanics (IUTAM, 2000-2008), bureau member of IUTAM since 2012, past member of the Executive Council of the European Community of Computational Methods in Applied Sciences (ECCOMAS, 1996-2009) and past-secretary general of the European Mechanics (EUROMECH 2005-2014). He has been member of the Panel PE8 “Process and Products Engineering” for Advanced Grants of the European Research Council (2009, 2011, 2013) and chairman in 2014 and 2016 of the same panel. He chaired the Evaluation Committee of the Faculty of Mechanical Engineering of the University of Technology of Eindhoven and the University of Twente (2014). He served also as an expert in the Scientific Committee of the “Commissariat de l’Energie Atomique” (CEA, 2004-2005) France and was member of the “Conseil d’Enseignement et de Recherche” de l’ Ecole Polytechnique, Paris (2003-2013).

Fellowship and Awards

He was elected Fellow of IACM in 1998, Member of the Galileian Academy, Padua in 2000, and was awarded a Doctorate honoris causa from the St. Petersburg State Technical University in 2000. In 2002 he was awarded a Doctorate honoris causa from the University of Technology of Lodz, Poland, and received the Computational Mechanics Award, (IACM); in 2005 he became Honorary Fellow of the University of Wales, Swansea (UK) and in 2006 he was awarded an honorary Doctorate in Engineering from the Leibniz University in Hanover, was nominated Chevalier de l’ordre des Palmes Académiques, France and received the IACM O.C. Zienkiewicz Award. In 2007 he was nominated Honorary Professor of the Dalian University of Technology in Dalian, China, and was elected Member of the National (Italian) Academy of Sciences (“dei XL”). In 2008 he was awarded a Doctorate honoris causa from the Russian Academy of Sciences. In 2009 he received the Maurice A. Biot Medal of the American Society of Civil Engineers ASCE. In 2010 he was awarded a Doctorate honoris causa from the Ecole Normale Supérieure in Cachan, France, and the Euler Medal from ECCOMAS. In 2011 he received the Olgierd A.Zienkiewicz Medal from the Polish Association of Computational Mechanics. In 2012 he was awarded the Lifetime Achievements Award from the International Conference on Computational & Experimental Engineering and Sciences (ICCES), was elected Member of the Istituto Veneto di Scienze, Lettere ed Arti ; in the same year appeared “*Bytes and Science*”, a book celebrating the 70th birthday of Bernhard A. Schrefler, (eds., G. Zavarise and D. P. Boso), CIMNE, Barcelona, Spain. In 2016 he was awarded a Hans-Fischer-Senior Fellowship from the Institute for Advanced Study, Technical University of Munich Germany, and the Gauss-Newton Medal (IACM Congress Medal). In 2017 he received the Interpore Lifetime Honorary Membership Award, of The International Society for Porous Media Interpore. On October 4, 2017 a meeting entitled “75 Jahre Prof. Bernhard Schrefler” and celebrating the 75th birthday of Dr. Schrefler took place at the Freie Universität Bozen – Libera Università di Bolzano UNIBZ.

Bernhard Schrefler is married to Chantal Saint Blancat, former professor of Sociology. They have a daughter Lorna, currently an economist at the European Commission, and a granddaughter Dalia.