Professor Bernt Johansson and LTU

Development of Steel Structures in northern Sweden

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ABSTRACT

Bernt Johansson, born in Stockholm in 1942. earned his MSc in Civil Engineering from the Royal Institute of Technology in 1961. He worked as a consultant engineer and continued his studies and presented his PhD thesis in 1976 on the stability of box-girder beams. In 1985 he was recruited to Luleå University of Technology to start research on steel structures. He initiated work with thin-walled structures, high strength steel and composite structures collaborating with industry. He played a pivotal role in the development of Swedish and European design codes. He supervised many master's, licentiate, and PhD students. He passed away in 2017.

Keywords: stability, thin-walled steel structures, composite structures, high strength steel, building codes.

1 INTRODUCTION

Bernt Johansson was born on July 13, 1942, and grew up in Stockholm. After graduating from high school in 1961, he followed with a MSc in Civil Engineering at the Royal Institute of Technology (KTH) in 1965. The studies were funded by teaching at Tekniska Institutet (TI) and participation in the excavations of the Vasa regal ship, sunken on her maiden voyage from Stockholm in 1628. In 1965 Bernt wrote his MSc Thesis under the supervision of Torsten Höglund, the start of a fruitful cooperation and friendship lasting for more than half a century. The MSc thesis, dealing with tests on plated girders with thin webs, was the start of research that ended in the so called "rotated stress field method" for shear strength, now included in EN 1993-1-5 Plated Structures, but also in EN 1999-1-1 Aluminium Structures, (1 - 3).

2 EARLY WORK

In an interview about Bernts Swedish code-writing activity he said that if he and Torsten Höglund had come to an agreement then it was settled (in contrast to Eurocode writing where it takes years to come to an agreement). Continuing research studies at KTH led to a doctorate in Byggnadsstatik (Structural Mechanics) in 1976 with Professor Henrik Nylander (4, 5). Bernts doctor thesis treats hat beams now widely used in Europe in what is called slim floors, where the beams are hidden within the height of the concrete slab. In parallel with his research studies, Bernt worked with development of design codes at Planverket (Swedish National Board of Housing, Building and Planning). Some codes he was involved in are illustrated in *Figure 1*, including the old one from 1938 which he had to start from. He was recruited to Bloms Ingenjörsbyrå in 1974, where he worked until 1990, the latter years as owner of the company.

Fig. 1. Some codes Bernt Johansson has been developing. Top from left: Swedish code SFS 1938:37, 1970 StBK-N1, and 1979 SBN 2A (introducing partial coefficients and safety classes). Bottom from left: 1987 Swedish code BSK, 2006 European code SS-EN 1993-1-5 and 2007 Commentary and worked examples on Plated structural elements (7, 10).

3 LULEÅ UNIVERSITY OF TECHNOLOGY, LTU

On January 1st, 1986, Bernt was, with the support of a donation from SSAB, appointed adjunct professor in Steel Structures at Luleå University of Technology (LTU). Luleå was Sweden's "steel" city, just south of the Polar circle close to iron ore fields in nearby mountains. Steel was produced, steel sheets were developed and manufactured for the building market and Bernt soon engaged in the development of this and other areas of steel construction (6, 7), and he was soon promoted to be a full professor. Bernt was an excellent and very popular supervisor having a way to explain complicated processes in a simple way. The Doctorate and Licentiate works he and his followers initiated are listed in *Table 1* and *Table 2*. In them, also many papers are listed, which he co-authored with his students, see also *Figure 2* and *Figure 3* (8 -12).

Fig. 2. Bernt Johansson ca 2017 (left) and 2002, receiving the Steel Beam (right).

Bernt Johansson was during 1993 - 1997 Chair of the Department of Civil Engineering and engaged in reforming administration to a flatter structure and to lower OH costs (13 - 15). He also started research in wood and timber structures and in 2004, a new Division with this subject was started with Lars Stehn as Professor.

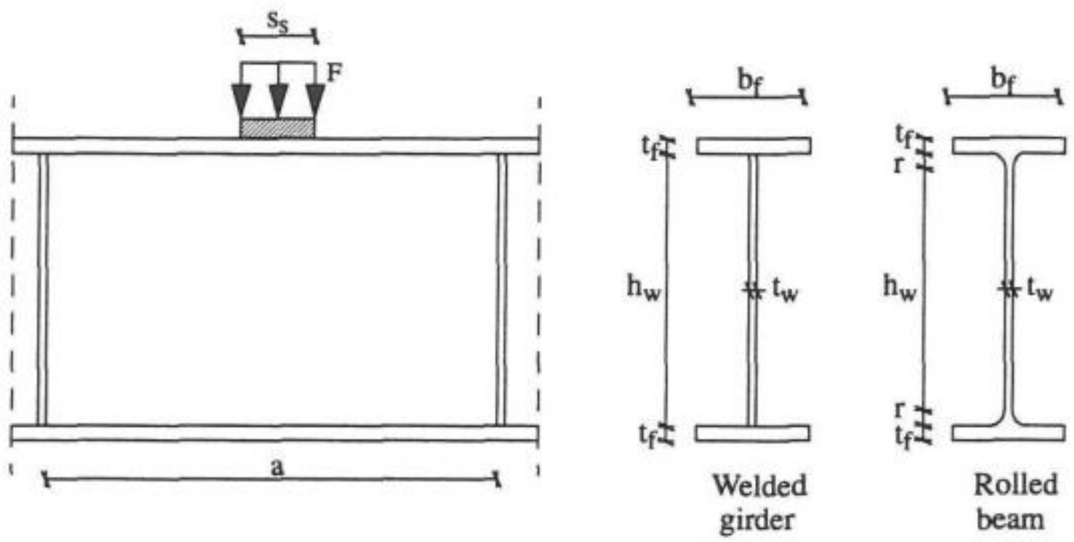

Fig. 3. Patch loading. Definition of Parameters. From the PhD thesis of Ove Lagerqvist (1995), see Table 1.

Bernt Johansson retired from the position as Professor and Head of the Division of Steel Structures in 2007. He was succeeded by Milan Veljkovic, who headed the Division until 2015, when he was appointed Professor of Steel and Composite Structures at Delft University of Technology in the Netherlands. During Milan Veljkovic’s time a new education program in Fire and Safety was initiated. Between 2015 and up to 2019 Ove Lagerqvist was acting professor in Steel Structures. During these times, Milan, Ove, and Peter Collin supervised the PhD students in *Tables 1* and *2*. The subject of Steel Structures was in 2020 merged into the Division of Structural Engineering with Gabriel Sas as new Professor. At the same time a new subject of Building Materials was split out from the earlier Division of Structural Engineering with Andrzej Cwirzen as Professor.

4 RESEARCH AND CODE WORK

An example of instability problems studied at LTU was inelastic local buckling of I-beam flanges. It was investigated by Mikael Möller in his PhD thesis, see Table 1 and (17). The flange buckling is modelled with a combination of torsional buckling and plate yield line buckling, see *Figure 4.*

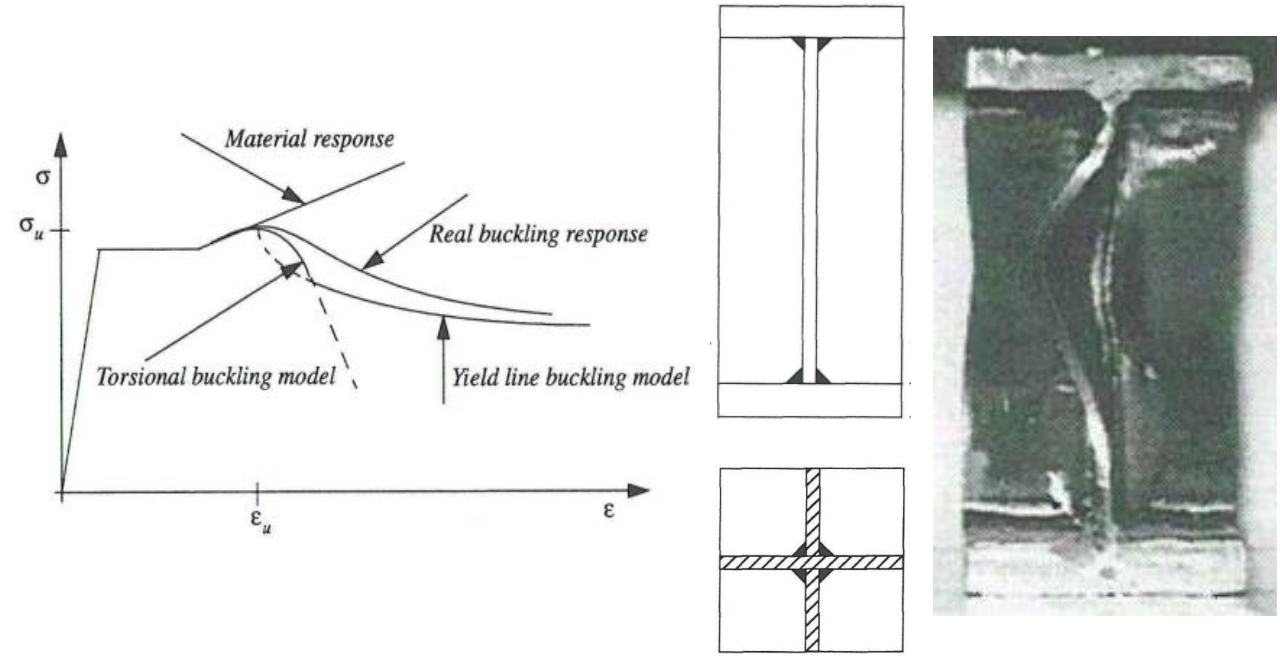

Fig. 4. Left: Concept for combination of torsional and yield line plate buckling. Middle: Drawing of tested column stub, Right:Test specimen after buckling of flanges. From PhD thesis of Mikael Möller, see Table 1 and (17).

Bernt Johansson was an active and very much acknowledged contributor to the development of Eurocode 3 and 4. He initiated a review of the texts with his PhD students. In addition to theoretical background and editorial checks, he supervised numerical examples to illustrate the use for Swedish practitioners. Especially during the conversion of the pre-standard ENV to EN he participated as project team leader in the development of EN 1993-1-5 (Eurocode 3 – Design of steel structures – Part 1-5: Plated structural elements) and as secretary in the project team for the development of EN 1994-2 (Eurocode 4: Design of composite steel and concrete structures – Part 2: General rules and rules for bridges).

His strong background in practice drove him to seek for simple but adequate solutions. On the other hand, he knew the importance of theoretically sound verifications. In a way his EN 1993-1-5 was also exemplary for that, because he early recognized the necessity of rules for "Finite Element Methods of Analysis (FEM)" and formulated the famous Annex C, which has formed the basis of verifications by advanced methods in steel engineering for years. He also introduced a course at LTU on "Applied FEM" covering basic examples of analysis using ABACUS and DIANA software. His vision made him convinced of the trend towards high strength steels, where he wanted the European steel market not to lose the competition against international trends in steel as well as further developments in concrete. "EC3 should not become an obstacle for development" was his motivation, when as convenor of the Working Group S690 he drafted "Additional rules for the extension of EN 1993 up to steel grades S 700", which later became EN 1993-1-12 (16).

Table 1. Doctoral Dissertations in Steel Structures and connected subjects 1991 – 2023. Bernt Johansson has co-authored many papers in the early theses, available at http://ltu.diva-portal.org/smash/

1991 Peter Collin: Vippning av stålbalkar i hallramar (Lateral-torsional buckling in portal frames, In Swedish), 1991:094D, 135 p.

1995 Ove Lagerqvist: Patch Loading. Resistance of steel girders subjected to concentrated forces. 1994:159D, 299 p.

1995 Claes Fahleson: Ice and Wind Loads on Guyed Masts. 1995:174D, 226 p.

1995 Mikael Möller: On Inelastic Local Flange Buckling. 1995:175D, 181 p.

1996 Milan Veljkovic: Behaviour and Resistance of composite slabs. Experiments and finite element analysis. 1996:207D. 181 p.

1997 Jan Granlund: Structural Plasticity: Experimental Study and Theoretical Modelling, 1997:24D, 229 p.

1998 Frank Axhag; Plastic Design of Slender Bridge Girders, 1998:09D, 207 p.

2001 Nils Olsson: Glulam Timber Arches – Strength of splices and reliability-based optimisation, 2001:12, 231 p.

2001 Anders Olsson: Stainless Steel Plasticity – Material modelling and structural applications. 2001:19, 295 p.

2001 Patrik Svanerudh: Design Support System for Multi-storey Timber Structures, 2001:20, 274 p.

2001 Eva Hedman-Pétursson: Column Buckling with Restraint from Sandwich Wall Elements, 2001:27, 209 p.

2002 Eva Sterner: Green Procurement of Buildings. Estimation of Environmental Impact and Life-Cycle Cost. 2002:09, 185 p.

2005 Katarina Ljungquist: A Probabilistic Approach to Risk Analysis. A comparison between undesirable indoor events and human sensitivity. 2005:41, 225 p.

2007 Jonas Gozzi: Patch Loading Resistance of Plated Girders – Ultimate and serviceability limit state.2007:30, 200 p.

2007 Mattias Clarin: Plate Buckling Resistance. Patch Loading of Longitudinally Stiffened Webs and Local Buckling, 2007:31, 202 p.

2009 Tobias Larsson: Fatigue assessment of riveted bridges, March 2009. 165 pp. ISBN 978-91-86233-13-6, 165 p. (Structural Engineering)

2013 Tim Heistermann: Stiffness of Reverse Channel Connections at Room and Elevated Temperatures, ISBN 978-91-7439-769-7, 239 p.

2014 Christine Heistermann: Resistance of Friction Connections with Open Slotted Holes in Towers for Wind Turbines, ISBN 978-91-7583-152-7, 19

2015 Hans Pétursson: Design of steel piles for integral abutment bridges. Oct 2015, 170 p. ISBN 978-91-7583-416-0.

2016 Naveed Iqbal: Analysis of Catenary Effect in Steel Beams and Trusses Exposed to Fire. Sept 2016. 240 p. ISBN 978-91-7583-649-2.

2017 Alexandra Byström: Compartment Fire Temperature Calculations and Measurements, ISBN 978-91-7583-813-7, 222 p.

2017 Pourya Noury: On Failure of High Strength Steel Bridge Roller Bearings, ISBN 978-91-7583-942-4, 120 p.

2018 Robert Hällmark: Composite Bridges. Innovative ways of achieving composite action. Nov. 2018, 282 pp, ISBN 978-91-7790-202-7. (Structural Engineering)

2018 Panagiotis Manoleas: Between Square and Circle. A study on the behaviour of polygonal steel profiles under compression, ISBN 978-91-7790-221-8, 128 p.

2019 Anh Tuan Tran: Resistance of cold-formed high strength steel sections – Effect of cold-formed angle. Sept 2019. 157 p. ISBN 978-91-7583-932-5.

2019 Joakim Sandström: The life safety objective in structural fire safety design. June 2019. 172 p. ISBN: 978-91-7790-361-1.

2020 Gabriel Sabau: Flexural buckling of high-strength steel columns. March 2020. 241 p. ISBN 978-91-7790-537-0.

Table 2. Licentiate Dissertations in Steel Structures and connected subjects 1991 – 2023
Most theses are available at http://ltu.diva-portal.org/smash/

1991 Leif Öhult: Hur bygga i kallt klimat (How to build in a cold climate. In Swedish). 1991:05L, 98 p.
1991 Agneta Wargsjö: Plastisk rotationskapacitet hos svetsade stålbalkar (Plastic rotational capacity of welded steel beams. In Swedish). 1991:15L, 131 p.
2001 Anders Stoltz: Effektivare samverkansbroar. Prefabricerade farbanor med torra fogar (More effective composite bridges. Prefabricated slabs with dry joints. In Swedish). 2001:41L, 195 p.
2002 Tomas Filipsson: Shear Walls with double plaster boards: Evaluation of design models, 2002:26L, 104 p.
2003 Emma Unosson: Patch loading of stainless steel girders: experiments and finite element analyses, 2003:12L, 56 p.
2008 Wylliam Husson: Friction Connections with Slotted Holes for Wind Towers, 2008:45 L, 213 p.
2011 Marouene Limam: FE modelling of friction connections in tubular tower for wind turbines. Dec 2011. 158 p. ISBN 978-91-7439-344-6.
2012 Björn Uppfeldt: Stainless steel box columns in fire. Analysis and design recommendations. March 2012. 144 p. ISBN 978-91-7439-419-1.
2012 Mattias Nilsson: Secondary strain in web stiffeners in steel and composite bridges. Sept.2012. 215 p. ISBN 978-91-7439-475-7. (Structural Engineering).
2013 Naveed Iqbal: Restrained behaviour of beams in a steel frame exposed to fire. June 2013. 195 p. ISBN 978-91-7439-631-7.
2013 Alexandra Byström: Fire temperature development in enclosures: Some theoretical and experimental studies. Nov. 2013. 164p. ISBN 978-91-7439-770-3.
2013 Joakim Sandström: Thermal boundary conditions based on field modeling of fires: Heat transfer calculations in CFD and FE models with special regards to fire exposure represented with adiabatic surface temperatures. Dec. 2013. 81 p. ISBN 978-91-7439-772-7.
2014 Anh Tuan Tran: Resistance of circular and polygonal steel towers for wind turbines. Down scale component experiments and finite element analysis. Nov 2014. 138 p. ISBN 978-91-7583-060-5.
2014 Pourya Noury: Fracture mechanics in design and assessment of existing structures: Two case studies. Nov 2014. 162 p. ISBN 978-91-7583-162-6.
2014 Pedro António Pimenta de Andrade: Innovative construction of student residences. Frameup concept. Nov 2014. 222 p. ISBN 978-91-7583-177-0.
2016 Jens Häggström: Evaluation of the load carrying capacity of a steel truss railway bridge: Testing, theory and evaluation. Dec. 2016. 139 p. ISBN: 978-91-7583-739-0. (Structural Engineering).
2023 Victor Vestman: I-girder Composite Bridges with Lateral Bracing – Improved load distribution. May 2023. 142p. ISBN 978-91-8048-287-5. (Structural Engineering).

Being already officially in pension in 2007, see *Figure 5*, he strongly supported his successor in this task to integrate now the rules of EN 1993-1-12 into the various other parts of the second generation of Eurocode 3. He also gave the following pieces of advice (7):

"*It is possible to influence European code work but it requires time and engagement. You must present good proposals, preferably the best. They should be verified scientifically but that is not enough. You must argue for them, make comparisons, and write background documents. Some times you succeed and sometimes you fail. That you must accept, and try again. Overall, the results with better codes with more clear rules is one joy, and a big network of researchers is another. So, I will close with the words of Edith Piaf:*
Non, je ne regrette rien."

Bernt Johansson was also engaged in many other projects as e.g. "Light Steel Framing" (18), and the major European research project "Sustainable Bridges – Assessment for Future Traffic Demands and Longer Life Lengths" with 32 partners during 2003 – 2007 (19). Here he collaborated on "Guidelines for Inspection & Condition Assessment" (ICA) and for "Loads & Resistance Assessment" (LRA), (20 - 21). He contributed to many other handbooks as e. g. several editions of the Swedish handbook BYGG (22).

Fig. 5. On June 1, 2007, many of Bernt Johansson's colleagues and friends at LTU participated in a trip to Hindersön in the Luleå archipelago, when he retired from the chair of steel structures.

5 FINAL WORDS

Bernt Johansson passed away on July 16, 2017, three days after his 75th birthday. He was closest to his wife Rosemary, daughter Filippa and her mother Agneta from his first marriage, and sister Lisbeth with family, but he is also missed by sailing friends, colleagues and former doctoral students and students. He travelled with them on study trips and invited them to his flat in Luleå at Varvsgatan, to his house in Danderyd, his summer house in the Stockholm archipelago and his second home in Portugal. He was a bold real estate investor but loosed some houses in the financial crisis in Sweden in the 1990ies.

Bernt was in his various roles as developer of design codes, creative designer, and curious researcher, a leading person in the Swedish steel construction society. His significance for the development of previous Swedish design codes for steel structures and the development of the current Eurocodes for steel structures can hardly be overestimated.

Just as important was that Bernt with enthusiasm, warmth and patience tried to advance his knowledge to new generations of steel designers. His efforts were acknowledged through the award "Silverbalken" (the Silver Beam, 2007) from the Swedish Institute of Steel Construction (Stålbyggnadsinstitutet, SBI) and the Charles Massonnet Award (2011) from the European Convention for Construction Steelwork (ECCS). However, for him, a more important recognition was the lifelong friendship relations developed with his PhD students and colleagues. In Bernt, a unique combination of deep knowledge, analytical sharpness and practical understanding was combined. This, along with his humility and aura of peace and security, led him to be respected far beyond the borders of Sweden.

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