

VB1. STRUCTURAL VIBRATIONS FROM RAILWAY TRAFFIC

<i>Supervisor</i>	Professor Sven Ohlsson, Dynamics in Design
<i>Doctoral candidate</i>	Johan Jonsson, MSc (appointed June 1995)
<i>Period</i>	1995-09-01 – 1997-06-30 (– 2001-12-31)
<i>Chalmers budget (excluding university basic resources)</i>	kSEK 1400
<i>Industrial interests budget (Banverket)</i>	kSEK 400
<i>Research programme</i>	PM Sept 1995 (2 pages)

Remarks: The purchase of extensive experimental equipment for vibration measurements principally in field trials has been funded by the Research Council FRN (approximately MSEK 2).

Knowledge on excitation mechanisms for buildings caused by the passage of a train is to be established. Mechanisms for the internal spreading of building vibrations, as well as criteria for maintaining levels of comfort, function and safety in the building, are also to be studied. Johan Jonsson has tested the applicability of various suggested models to the generation of mechanical waves in the ground by a train. An experimental study has been carried out in Halmstad with parallel measurement of train-generated vibrations in the ground and in a nearby building. Field tests of homogeneous clay subjected to controlled impact loads have been carried out north of Göteborg.

A linear elastic finite element model has been established for the volume of ground in question. A comparison between the transmission functions measured and calculated shows reasonable agreement in the frequency range studied up to about 12 Hz.

Investments to a value of approximately MSEK 2 have been made in new measuring equipment at Chalmers Dynamics in Design with support from the Research Council FRN. Considerable work has been put into adapting the sensor equipment so that it can also be used for measurement below ground surface. Extensive three-dimensional measurements of vibration fields at and below ground surface have been planned (and have been carried out) in homogeneous clay at Alvhem during the autumn of 1997. Banverket's loading wagon was used to generate concentrated dynamic forces to the track. Measurements of ground vibration fields caused by the actual passage of trains are also included in the project. Reports from the work during Stage 1 are listed below:

Johan Jonsson: A literature survey of railway induced ground vibrations into buildings, *Chalmers Dynamics in Design*, Report D96:2, Gothenburg 1996, 16 pp

Johan Jonsson: Measurements of railway induced building vibrations at the Furet block in Halmstad, *Chalmers Dynamics in Design*, Report D96:3, Gothenburg 1996, 60 pp

Johan Jonsson: Ground vibrations – field measurements and prediction using finite element technique, *Proceedings XVth IMAC (International Modal Analysis Conference)*, Tokyo, September 1997, pp 594-600

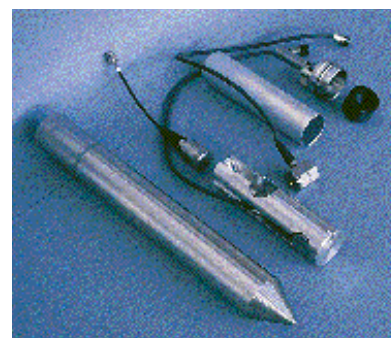


PhD student Johan Jonsson (left) and his supervisor Professor Sven Ohlsson in Project VB1

Banverket's Track Loading Wagon (TLW) exiting the track during the field experiments at Alvhem in Project VB1



Sensor equipment designed and built by Chalmers Dynamics in Design for triaxial underground vibrational measurements in Project VB1



VB2. NOISE FROM TREAD-BRAKED RAILWAY VEHICLES

<i>Supervisor</i>	Dr Roger Lundén, Associate Professor, Solid Mechanics
<i>Doctoral candidate</i>	Tore Vernersson, MSc (appointed March 1994)
<i>Period</i>	1995-07-01 – 1997-06-30 (– 2000-06-30)
<i>Chalmers budget (excluding university basic resources)</i>	kSEK 600 + 100
<i>Industrial interests budget (Adtranz)</i>	kSEK 600
<i>Research programme</i>	PM 1995-II-10 (2 pages)

PhD student Tore Vernersson analyzing the rim and disc of a wheel in Project VB2



Remarks: Part of a larger project with parallel funding direct from Adtranz Wheelset and from NUTEK. The additional allocation of kSEK 100 was granted in November 1996 for the purchase of extra equipment.

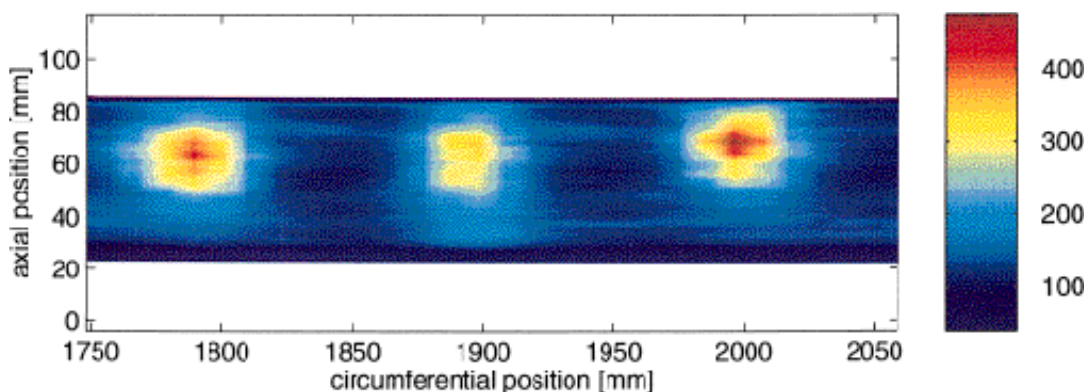
Tore Vernersson gained his licentiate's degree on 29 September 1997. Dr Adam Blomberg (previously at Materials Technology/Tribology at the University of Uppsala, now at Volvo Technical Development) then acted as discussion leader. Part of this work was included in a parallel NUTEK project during 1995-96, a fact which contributed to the positive development of VB2.

During the two-year period, work has been carried on together with Adtranz Wheelset in Surahammar on theories and experiments concerning the mechanisms behind the origin of non-roundness on the wheel tread caused by block braking. Staff from Chalmers Solid Mechanics (Erik Hult, MSc, and technician Hans Johansson), in co-operation with staff at Surahammar and consulting experts in temperature measurement (AGEMA Infrared Systems AB), have contributed to the planning

and performance of the tests. Simultaneous registration of tread temperature and block dynamics is carried out, and unevenness on the tread is measured after braking and cooling. There has been co-operation with the EU project EuroSABOT in which, among others, KTH (Royal Institute of Technology) and NS (Nederlandse Spoorwegen) have taken part in the experiments. ABB Corporate Research have also been involved. An extensive study of the literature has been carried out and documented. Undergraduates working on their degree papers have been engaged. Olaf Kämmerling from TU Berlin has been a visiting foreign undergraduate working on his degree. Reports during Stage 1 from the research group are listed below:

Tore Vernersson and Roger Lundén: Stresses in Re-locomotive tyres – on the influence of shrink-fit and braking stresses on rolling contact fatigue, *Chalmers Solid Mechanics*, Report F183, Gothenburg 1995, 45 pp

Tore Vernersson: Non-roundness of block-braked railway wheels – a literature survey, *Chalmers Solid Mechanics*, Report F186, Gothenburg 1996, 63 pp



The hot spots developed on the wheel tread during block braking were photographed with a scanning thermovision camera (2500 lines/sec) during the full-scale experiments in Project VB2

VB3. NOISE RIG

Olof Cato, Tomas Göransson, Peter Johansson and Anders Lindberg: Acoustically short-circuited railway wheels – a preliminary experimental study, Student Report, *Chalmers Solid Mechanics*, Gothenburg 1995, 39 pp

Olaf Kämmerling: Vibrational modes of railway wheels, Student Report, *Chalmers Solid Mechanics*, Gothenburg 1995, 32 pp

Kent Ackemo: Flexible wheels for railway vehicles, Student Report T146, *Chalmers Solid Mechanics*, Gothenburg 1996, 88 pp

Martin Petersson, Tore Vernerson and Roger Lundén: Research on roughness generation and growth, Chapter 5 (pp 35-52) of State of the art – final report (editor G J Bazuin), *EuroSabot Technical Report 1N6G30T1.DA*, NS, Utrecht 1996, 65 pp (+ annexes)

Martin Petersson and Roger Lundén: Thermal buckling of railway wheels, *EuroSabot Technical Report 2H6O07T1.OA1*, Chalmers Solid Mechanics, Gothenburg 1996, 10 pp (availability restricted)

Martin Petersson, Tore Vernersson and Roger Lundén: Full-scale block braking of railway wheels – Experiments performed on the Adtranz/Chalmers inertia dynamometer to investigate the roughness growth of freight car wheels, *EuroSabot Technical Report 2H7U25T12.OB*, Chalmers Solid Mechanics, Gothenburg 1997, 55 pp (availability restricted)

Tore Vernersson: Thermally induced roughness of tread braked railway wheels – a noise-related problem, Thesis for the Degree of Licentiate of Engineering, *Chalmers Solid Mechanics*, Gothenburg 1997, 77 pp

Tore Vernersson, Martin Petersson and Martin Hiensch: Thermally induced roughness of tread braked railway wheels (to be presented at *12th International Wheelset Congress* in September 1998 in Qingdao, China)

Tore Vernersson: Thermally induced roughness of tread braked railway wheels (submitted for international publication)

Project leader

Dr Roger Lundén,
Associate Professor,
Solid Mechanics

*Chalmers budget
(excluding university
basic resources)*

kSEK 800

*Industrial interests
budget*

kSEK 200 (*Adtranz*)
kSEK 200 (*Abetong*)
kSEK 200 (*Banverket*)

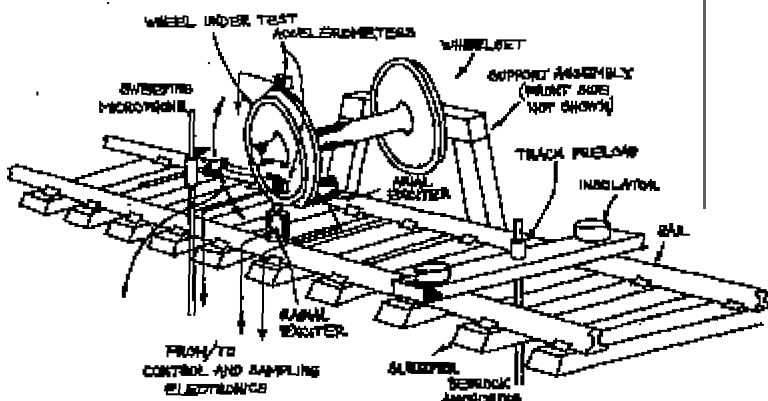
Remarks: ABB Corporate Research have also contributed to the noise rig both directly and through the EU project Silent Freight.

An agreement for the construction of a test rig for advanced noise measurements has been reached between seven parties. They are ABB Corporate Research, Abetong Teknik, Adtranz Wheelset, Banverket, Chalmers University of Technology, sj and SP (the Swedish National Testing and Research Institute). CHARMEC contributes financially as above. The rig will be owned and administered by Adtranz Wheelset under the terms of a special agreement.

A stretch of full-scale track is being built outdoors on the Adtranz Wheelset's plant site. It will be possible to measure noise radiated from track and wheelsets separately. The excitation of track and wheels occurs separately at their respective contact points (but with the same counter-directed dynamic forces). Sweep microphones are used for the determination of sound levels and directivity. Computer equipment and software for control and data collection are being developed at Chalmers Solid Mechanics by Research Engineer Erik Hult. Reports from the work on the noise rig are listed below:

Urban Olin and Anneli Sandelius: Sinussvepsgenerator för bullermätssystem (Sine sweep generator for noise measuring systems, in Swedish), *Department of Electrical Engineering, Chalmers College of Applied Engineering and Maritime Studies*, Student Report 97:34, Gothenburg 1997, 22 pp

Leonard Hillkirk: Evaluation of a contact-free electro-mechanical exciter of train wheels, *Department of Electrical Power Engineering, Royal Institute of Technology*, Student Report (in preparation)



An early design sketch of the test rig for noise measurements in Project VB3