KTH Railway Group

Centre for Research and Education in Railway Technology

2011-01-20
KTH Railway Group
- System approach

Revenue

Efficient train system

Cost

Profitability

Competition/Cooperation
KTH Railway Group – an interdisciplinary organisation

Board
Trafikverket, KTH, Bombardier, Train Operators m fl

Director
Prof. Stefan Östlund, EKC

Transport and Logistics
Adj. Prof. Bo-Lennart Nelldal

Construction Technique
Prof. Raid Karoumi

Railway engineering
Prof. Mats Berg

Light Constructions
Tekn. Dr. Per Wennhage

Noice and Vibrations
Tekn. Dr. Ulf Carlsson

Electric machines
Prof. Stefan Östlund

Vehicle dynamics
Ass. Prof. Lars Drugge

Machine Elements
Tekn. Dr. Ulf Olofsson

KTH Railway Group • Center for research and education in Railway technology
KTH Railway Group

Key activities:

- Research and postgraduate education
- Undergraduate education
- Courses for professional engineers
- Seminars
- Consulting
KTH Railway Group

- General agreement with
  Banverket (Trafikverket)
  Bombardier Transportation
  Association of Swedish Train Operators
  Stockholm Transport (SL)
  Interfleet Technology

- About 20 senior researchers
- 15-20 PhD students
- More than 25 PhD degrees since 1995
- About 60 scientific papers annually
- Turn-over >1.5 MEuro/year
Undergraduate education

- Vehicle System Technology, 8 credits
- Rail Vehicle Technology, 7.5 credits
- Rail Vehicle Dynamics, 8 credits
- Railway Traffic - Market and Planning, Basic Course, 7.5 credits
- Railway Traffic - Market and Planning, Advanced Course, 7.5 credits
- Railway Signalling System, 7.5 credits
- Railway Signalling System – Reliability, 7.5 credits
- Railway Signalling System - Project Planning, 7.5 credits
- Train Traffic Simulation, 7.5 credits
- Road and Railway Track Engineering, 7.5 credits
- Electric Traction, 6 credits
Implementation of research results

Wide body trains with Bombardier Regina-trains

- Capacity + 20% seats per wagon
- Cost cut -15% per passenger kilometre incl all costs
- Passenger valuation of 2+3 seating instead of 2+2: - 2%
- 100 trains ordered or delivered in Sweden + 80 trains to China
- Order value 19 billions SEK of which 7 billions in Sweden
Gröna Tåget research programme

KTH collaboration with Bombardier Transportation, Banverket, Swedish Train Operators, Interfleet, Transrail, VTI, Chalmers ...

Development of a new generation high-speed trains (>250 km/h) for Swedish conditions. Main topics:

- Track-friendly bogies
- Carbody tilting
- Active lateral suspension
- Aerodynamics
- Energy consumption
- External noise
- Permanent magnet traction motors
- Vehicle and traffic concepts
Gröna Tåget research programme

The Green train / Regina 250 test bench

STEP 1

Modified radial steered bogies

Bogie noise shield

STEP 2

Modified radial steered bogies with active lateral suspension

Mechatronic bogies

Bogie noise shield
Active Lateral Suspension (ALS)

Example of measurement result ($v = 240$ km/h)

The ride comfort is significantly improved
Gröna Tåget – External noise (ex.)
Division of Rail Vehicles: Research focus

- Vehicle-track dynamic interaction
  - Contact mechanics and wear prediction
  - Active suspension
  - Tilting trains
  - Freight wagon dynamics
  - Crosswind stability

- Energy consumption and environmental impact

- Lightweight structures

- Vehicle-catenary interaction
Gröna Tåget - Energy consumption

Top speed (km/h)

- 250+ Gröna Tåget *(future)*
- 200 X 2000 high-speed train *(2004)*
- 160 Loco hauled train *(1994)*

Lower energy consumption in spite of higher speeds:

- Reduced aerodynamic drag coefficient
- Electric regenerative braking used extensively
- Efficient on-board space utilization
- Improved electric propulsion system

*) Corresponding to 0.05 litre petrol per 10 km for one person in a car
TOSCA - Energy consumption

Rail passenger transport

Average new rail vehicles in Europe 2009 at mixed operation

- High-speed electric: 0.067 kWh/pkm
- Regional electric: 0.100 kWh/pkm
- Regional diesel: 0.208 kWh/pkm
- Local city electric: 0.106 kWh/pkm

pkm = passenger kilometre
Adhesion research activities
Department of Machine Design at KTH
together with: Trafikverket, SL, Transrail,
Sten Löving Optik, Sheffield University, Network Rail

- Top on rail surface layer
- Rail eye optical sensor
- Snow induced low friction in brakes
- Adhesion with rock salt/moisture present at low temperatures
- Adhesion modelling
- FATT Förutsägbara Adhesionsförhållanden för Tunga Tåg
Field test (Brommaplan)

Rail eye
optical sensor

Rail friction Coefficient in different conditions

- Clean rail
- Ice on rail
- Blackish layer on rail
- Oil on rail
Dynamic pantograph-catenary interaction
Centre for ECO² Vehicle Design

Lightweight carbody for high-speed trains

- **Stockholm Metro**

- **Tilting Train eXpress (Korea)**

  - Foam core with steel skins
  - 30% increased aisle space

  - Aluminium honeycomb core with graphite/epoxy skins
  - 30% weight saving
Centre for ECO\textsuperscript{2} Vehicle Design

Crosswind stability and unsteady aerodynamics

ICE 2 cross-wind simulation

Aerodynamics loads calculated with CFD
Railway related research at Dep. of Civil & Arch. Eng.

1. Enhanced assessment of the remaining service life of existing railway bridges

2. Development and testing of new monitoring techniques for increased safety and improved operation and maintenance of railway bridges

3. Dynamic behavior of bridges subjected to high speed trains

4. Ballast behaviour and Train-Track-Bridge interaction

5. LCA and LCC of railway infrastructures
Example of project type 2
Instrumentation of the new Årsta bridge

- Temperaturgivare
- Fiberoptiska töningsmätare, 3 st tvårs bron, 0,4 och 2 meter långa.
- Accelerometer, vibrationsmätning vid tågpassage.
- Elkabel
- Fiberoptik i plaströr
- Trädtöjningsgivare 3 st i bronns ländriktning, 0,3 meter långa.

Brospann med mätutrustning i fem sektioner

Nya Årstabron

Liljeholmen Södermalm Årsta

Banverkets fotomontage av nya järnvägsbron mellan Årsta och Tantolunden.
Railway Traffic Planning
- research fields

- Passenger transport
  – Supply and demand
- Freight transport
  – Supply and demand
- Capacity analyses
  – Simulation and models
Passenger
- The effects of the new Svealand line ex post ex ante - Dr thesis
- The Green Train project – market and planning - interdisciplinary
- High Speed Train in Sweden – forecasts and socio-economic analysis

Freight
- Model of supply and costs for freight trains - Dr thesis
- Efficient Freight trains – interdisciplinary project
- Evaluation of inter-modal transport-chains – SiR-C-project
- Small-scale intermodal transport system – PhD project

Capacity
- Capacity and quality in rail traffic – Dr thesis
- Congestion on tracks – volyme-delay for rail – Phd project
- Time table planning with simulation – PhD project
A study of the effects of the new Svealand line
Stockholm-Eskilstuna ex post ex ante

Regional trips (millions per year)

- Car
- Estimated regional travel
- Long-distance express bus
- Södermanland county PTA buses
- SJ bus
- Train
  - The Svealand line

KTH Railway Group • Center for research and education in Railway technology
The intermodal terminal in Malmö
Movements registered by GPS
Handling of swap-bodies in Malmö intermodal terminal

Measurements of accelerations

Measurements of movements and speed
Capacity research program at KTH

- Simulation model: Implementation of Railsys in Sweden
- Overtaking dtrack: Traffic structure - speed, Consumed capacity
- Botnialink: Traffic struktur-capacity, Simulation
- Single track: Meeting points-partial dtrack, Analytic model
- Double track: Disturbances-Traffic struktur, Simulation
- Single track: Planned or unplanned crossings
- Congustied track: Capacity and delays, Simulations and statistics
- Crossings: Crossing train points, stops, Analytic model
- Time table planning with simulation: Development projects
- Competence development: KTH-BV-Industry
- Consultant work: Kapacity analysis, Simulation
- Education: Railway traffic planning, Simulation

KTH Railway Group • Center for research and education in Railway technology
Delays for passenger trains

Delayd trains
% per link
More than 1 minute

Median delay in minutes per 100 km for delayed trains

Standard-deviation
In minutes per 100 km
Implementation of research results
- Analysed 2005, decided 2006 built to 2010 in “kraftsamling Mälardalen”

- More (short) crossing stations: Average distance decrease from 15 km to 7,5 km
- Extension of partial double track to Nykvarn: One more stop in this section and restricted speed in the point along the line will disappear
- Crossing station at Strängnäs decided and built as soon as possible
Information:

Hemsida:

www.railwaygroup.kth.se

stefan@ets.kth.se