Modeling optimal design speed for new high-speed lines

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July 12, 2012: System Optimization
Content

- Optimal design speed – what is that?
- The HSLdim model
- Benefits and demand functions
- Cost functions
- Conclusions

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Evolution of design speed
New high-speed lines at the year of opening

![Graph showing the evolution of design speed](image)

**Increasing design speed by time**
– Technically feasible, or optimal?

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Finding optimal design speed

Optimal speed dependent on costs AND benefits
– Are the demand functions sophisticated enough?
HSLdim model structure

Optimization of the high-speed line’s design speed in socio-economic terms by maximizing the benefit-cost ratio (CBA)
Model prerequisites

- Design speed for planning of new high-speed lines
  *European HS category 1 definition: v=250 km/h or more*

- Speed range 250-500 km/h
  *Including future planning options*

- Optimization of the benefit-cost ratio (CBA)

- Future-proof planning needs preparedness for changed prerequisites
  *For example from a single line to a network*
Travel demand model structure

Calculation for each OD-pair

- Total demand increase by high-speed
  (function of travel time; \( t \) time)

- Market model (\( t \) time) for the high-speed range (250-500 km/h)

- Demand elasticities for fare and frequency sensitiveness

Calculation of each year of the whole operating period

Annual total demand increase

Calculation of a reference year

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Market model
Example with a new high-speed line, design speed 250 km/h

Commercial train speed: 200 km/h
Infrastructure costs for new high-speed (HS) lines

- Construction and maintenance costs
  - Speed dependent costs (within the HS range 250-500 km/h)
  - Costs with no or weak speed dependency within the HS range
  - Swedish and other European examples

- Examples of some cost-drivers: Construction of ballast-less track including a ground frost-proof substructure (but necessary at ultra-high speeds), share of bridges and tunnels

- Examples of some HS costs with weak correlation to design speed: Communications and signalling, capacity at stations
Train operating cost (total)
The Green Train (Gröna Tåget) cost model for high-speed operations

- Generalized costs for a possible future high-speed train concept
- Includes Capital, Maintenance, Energy, Personnel, Track Access Charges (TAC), Administration and Sales costs
- By services/operations, thus speed dependent

![Train operating costs graph](image)
Conclusions

- **The model not applied yet**
  - Implementation 2012
  - Calibration and verification
  - Swedish and other European examples could be analyzed (but might need a new data set)
...Thank you for your kind attention