THE LOW-NOISE POTENTIAL OF LOW-VIBRATION TRACK

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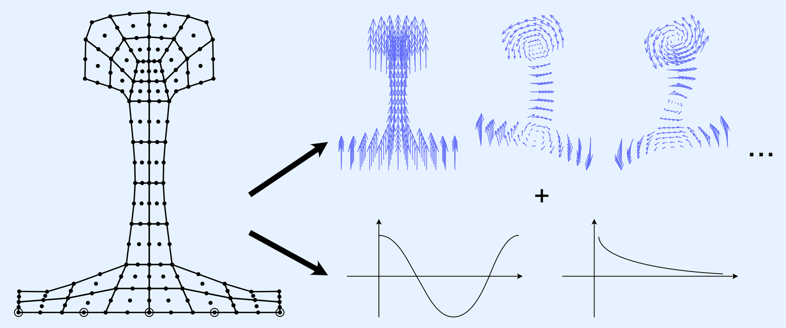
INTRODUCTION

- Low-vibration track (LVT) is a non-ballasted (slab) track developed for reducing ground vibrations
- Vibration and noise are excited by wheel and rail roughness in rolling contact
- Slab tracks produce higher rolling noise than ballasted tracks
- Why? Lower rail pad stiffness in slab tracks
  → decoupling of the rail
- LVT has a two-stage elastic support
  → allows tuning involved elasticities

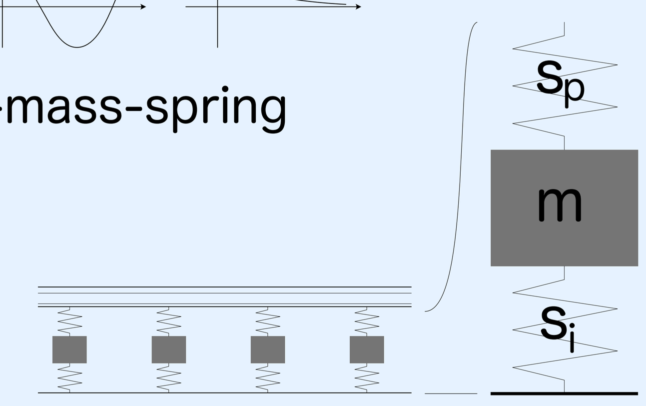
Can we tune the two elasticities to preserve low ground vibration and reduce radiated airborne noise?

METHODS

- Track decay rate (TDR) is noise indicator
- Higher decay → shorter rail section radiates
- Rail modeled as infinite waveguide (WFEM)



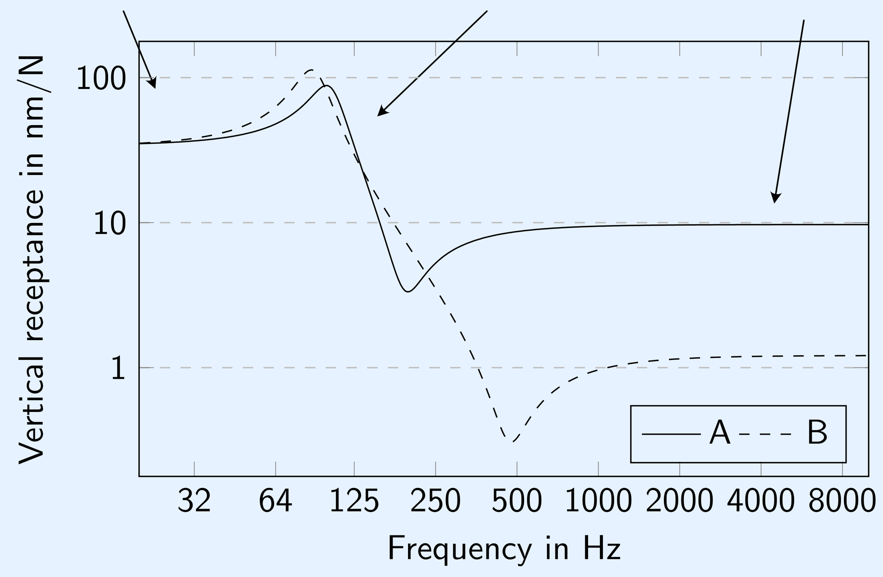
- WFEM coupled to spring-mass-spring system at each rail seat

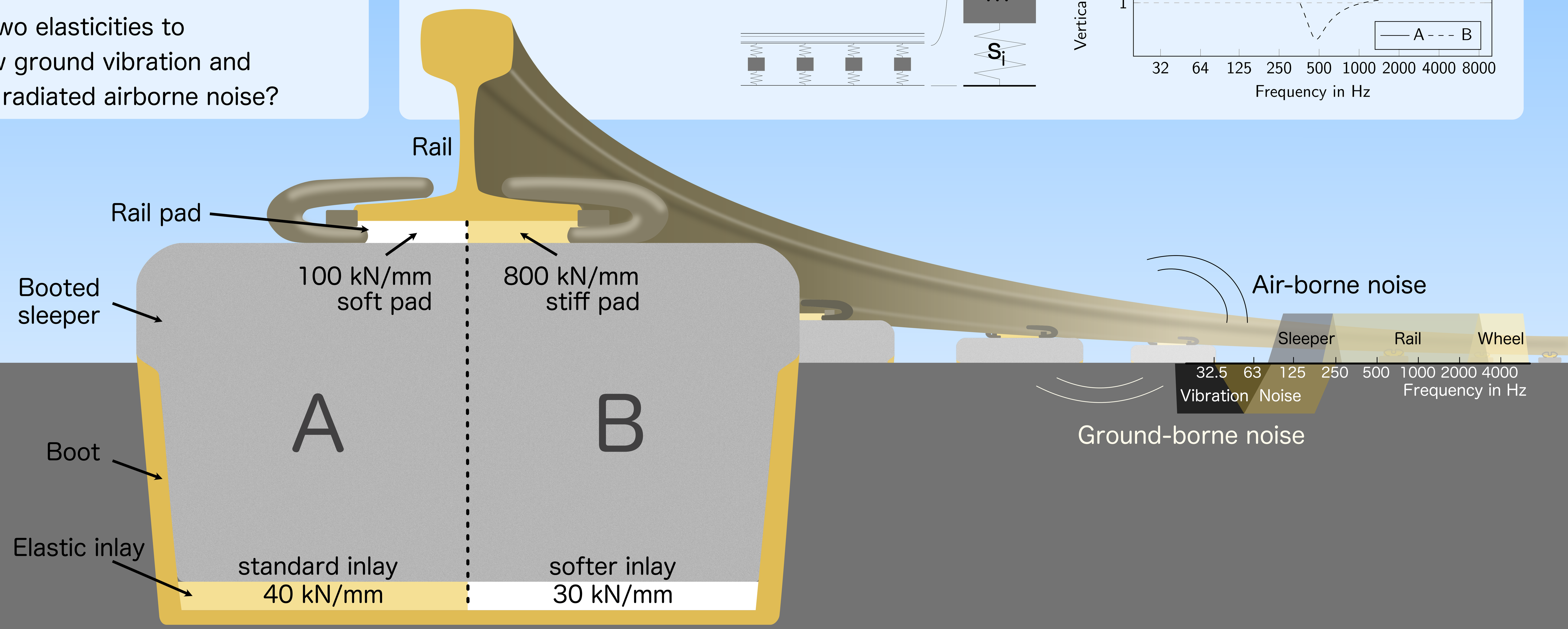


- Receptance R under the rail foot is modeled as

$$R = \frac{1}{s_i - \omega^2 m} + \frac{1}{s_p}$$

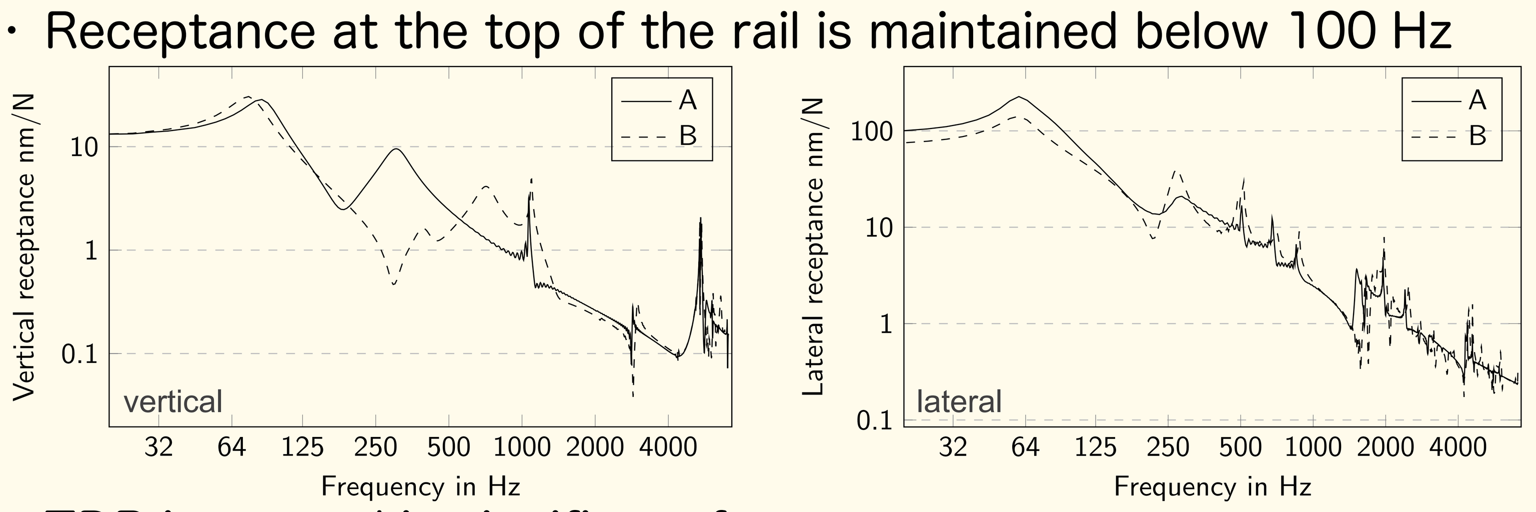
Inlay stiffness
Sleeper mass
Rail pad stiffness



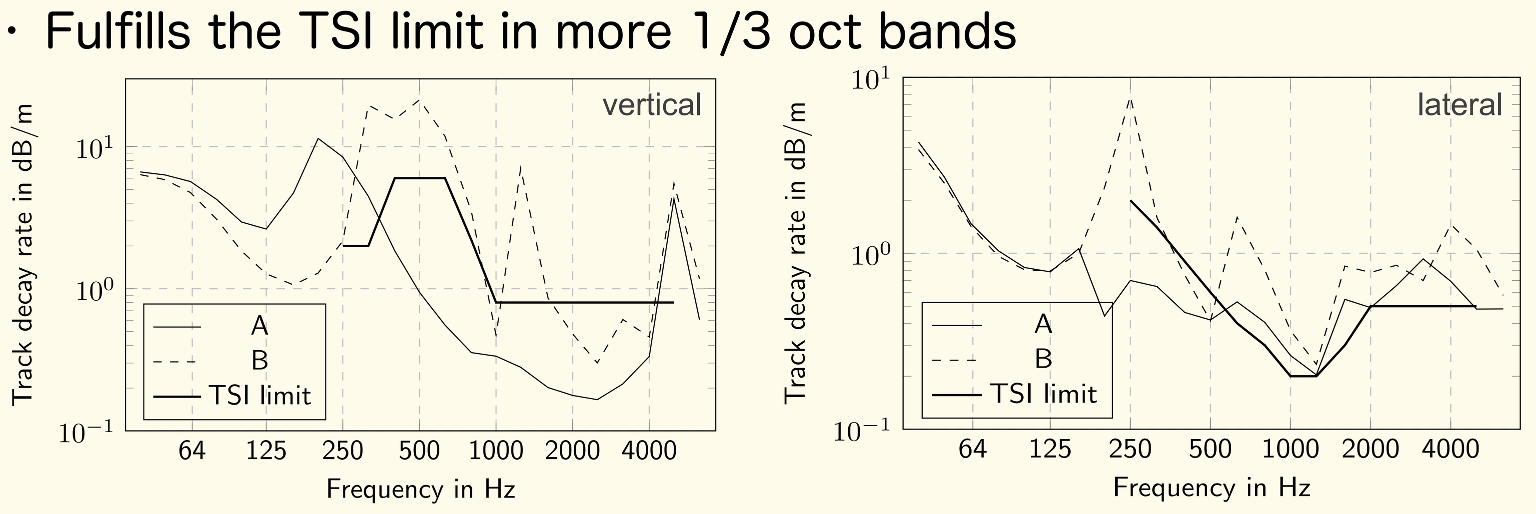


RESULTS

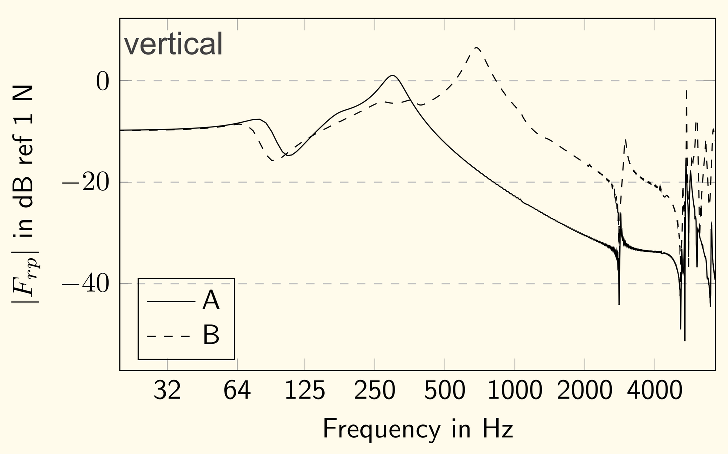
- Receptance at the top of the rail is maintained below 100 Hz



- TDR increased in significant frequency range
- Fulfills the TSI limit in more 1/3 oct bands



- Increased forces on the rail seats and sleepers



The increased TDR between 250 Hz and 2000 Hz indicates a lower sound radiation from the track. The stronger coupling between the rail and the sleeper leads to higher forces on the sleeper and indirectly on the wheel-rail contact.

DISCUSSION

- Soft suspension at low frequencies maintained
- Increasing pad stiffness is known to reduce radiated noise from track
- Problem: increasing contact forces → higher chance of corrugation → noise
- Possibly higher costs for rail grinding
- However, comparatively low investment costs compared to noise barriers, etc.
- Could be used on tracks where other noise reduction methods are unfeasible
- Further research: quantifying sound pressure difference and comparing to actual measurements in cooperation with SBB

CONCLUSIONS

- Developed a model for predicting TDR on LVT
- Increasing rail pad stiffness and compensating by decreasing inlay stiffness
  → higher TDR in relevant frequency range while maintaining soft response at low frequencies
- Further investigation into the effect of increased contact forces recommended

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