TAMPEREEN TEKNILLINEN YLIOPISTO

New more elastic turnouts in Finland

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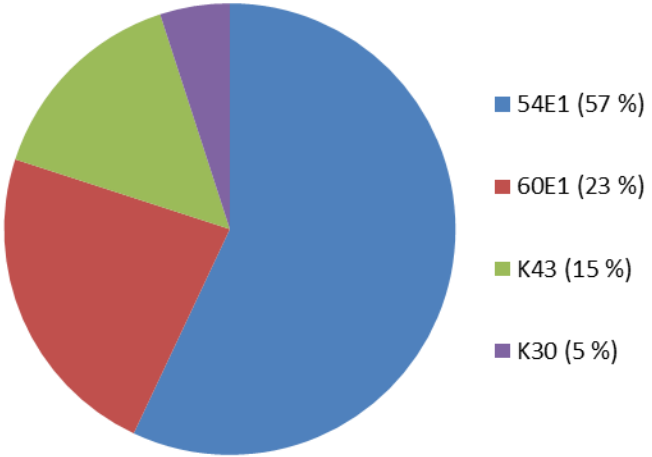
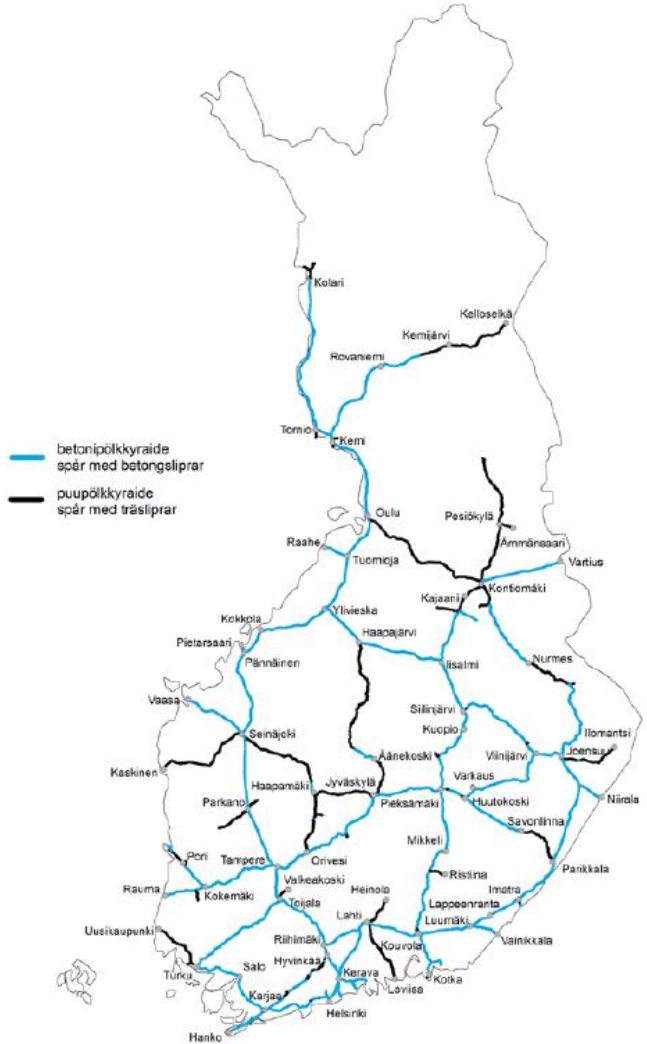
- Department Civil engineering
  - Earth and foundation structures
    - Personally I am coming from Dep. of Mechanical engineering
- Unit of Railway structures
  - Currently employing about 10 people
  - Led by Heikki Luomala
- Strong contribution from the Finnish Transport Agency
- Also other partners:
  - Luleå University of Technology, Norwegian University of Science (NTNU), CQ University (Australia), University of Alberta, Transportation Technology Center, Inc (TTCI), Parma Rail, Teknikum, VR Track, Vossloh Nordic Switch Systems…

Backround

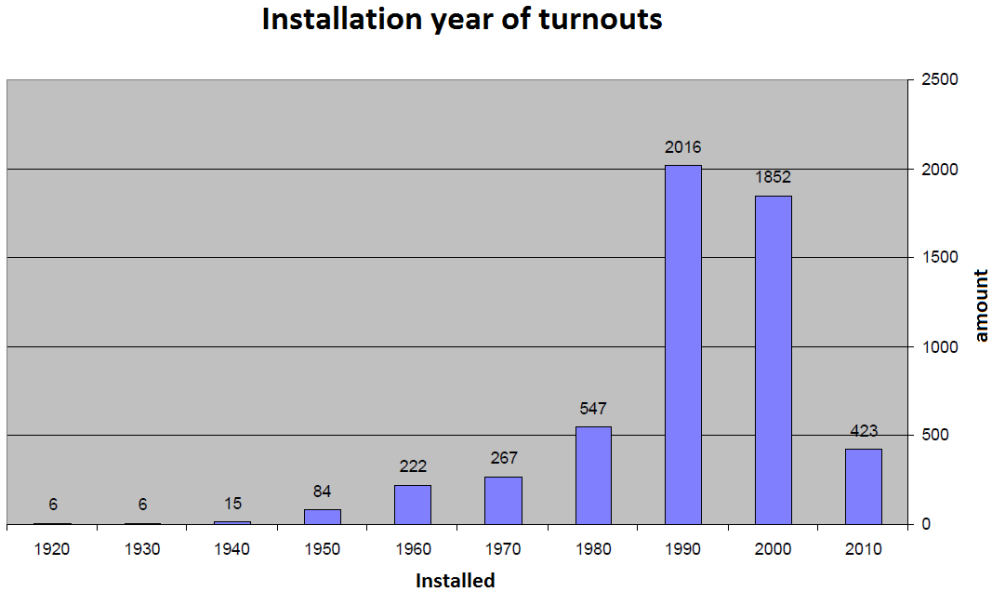
- There are currently about 5500 turnouts in Finland
- 90 % of those are single turnouts





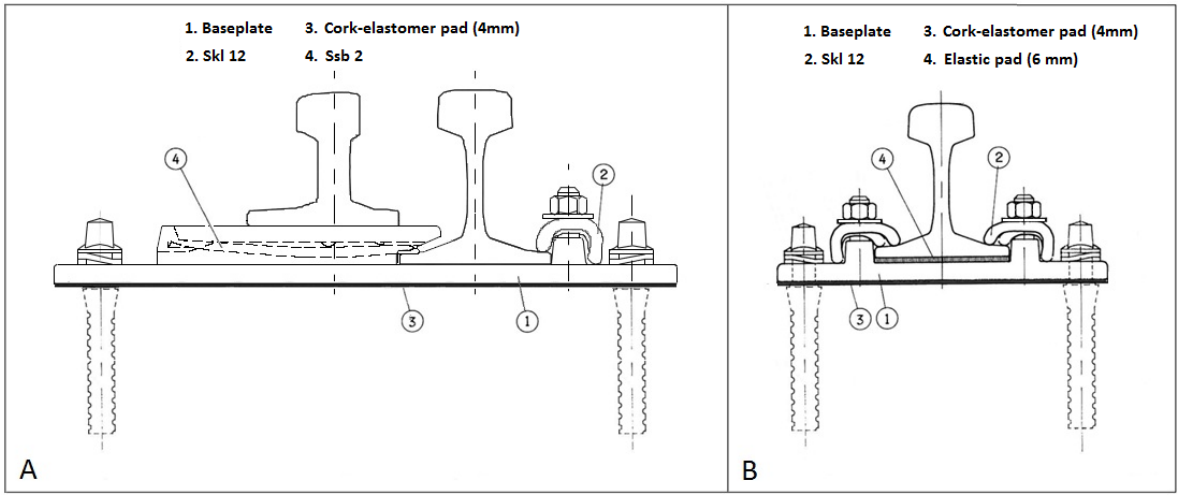
The age of turnouts

- Turnout design is nowadays quite old in Finland.
- There are many solutions which are used only because nobody hasn't suggested anything else.



Main problems 1/3

- The entire structure of Finnish turnouts is rather stiff.
- In the switch area structure doesn't include any elastic pads (picture A). The same situation is also in the crossing area.
- There is always cork-elastomer pad under baseplate, but that is just to avoid contact between baseplate and sleeper. (stiffness > 300 kN/mm)
- In the middle part there is normal elastic pad under stock rail (picture B). (stiffness ~ 130 kN/mm)

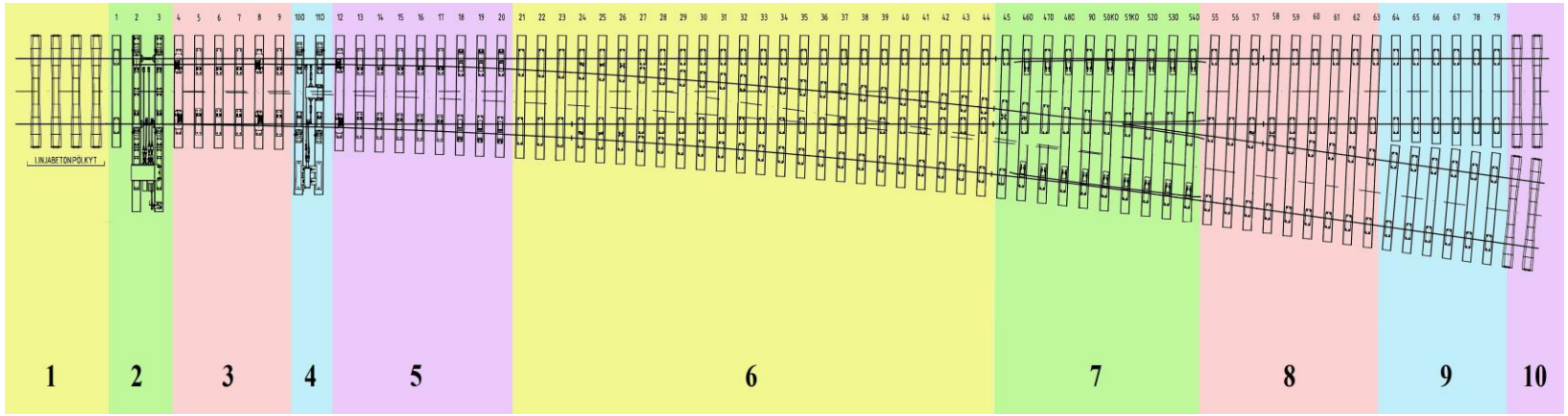


Main problems 2/3

- The driving rods of actuators are positioned in between two sleepers which mean that mechanical tamping in this area is not allowed.
- Sleepers starts to settle over time and dynamic impacts are increasing.
- Low temperature and snow is forcing us to use inner locking system and so on interaction between switch blade and stock rail cannot be controlled.
- To ensure safety in the point machine area, stock rail is fixed to the two bearers without proper elasticity.

Main problems 3/3

- These structural changes creates too many different elastic zones in the turnout and leads to big dynamic loads

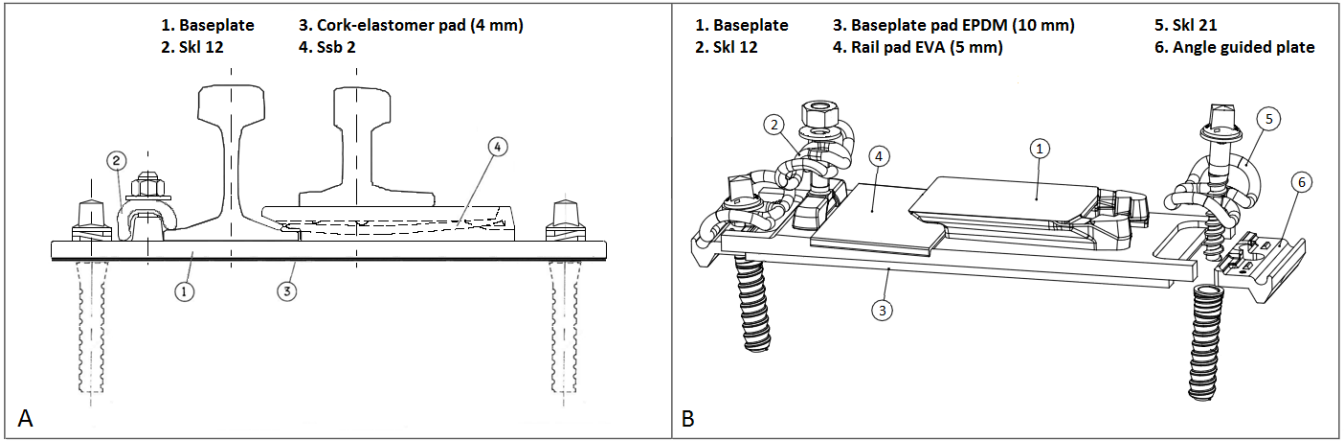


Development of the switches

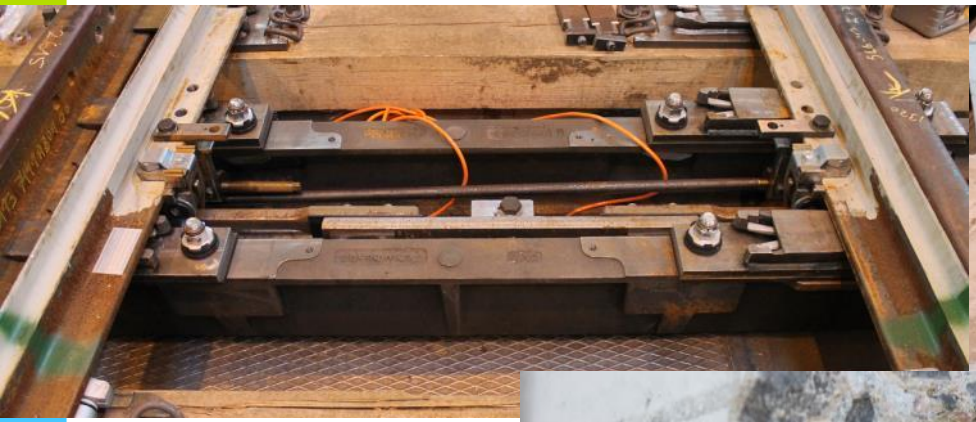
- For these reasons Finnish Transport Agency (FTA) started a development project in 2012, which goal was to improve the elasticity of the structure of switches and bring that closer to the normal main line structure. That would also bring continuity to the overall structure.
- This development project led to two new more elastic 60E1-300-1:9 prototype turnouts which were installed in Kouvola on Autumn 2014.
- University has been involved in this development from the beginning and also took care of the monitoring of these turnouts.
- The monitoring period has ended in August 2016 and the final report about the results will be published during this year.
- Good experiences about these turnouts has encouraged FTA to continue this development and two long 60E1-900-1:15,5 prototype turnouts were installed in Oulu on June 2016.

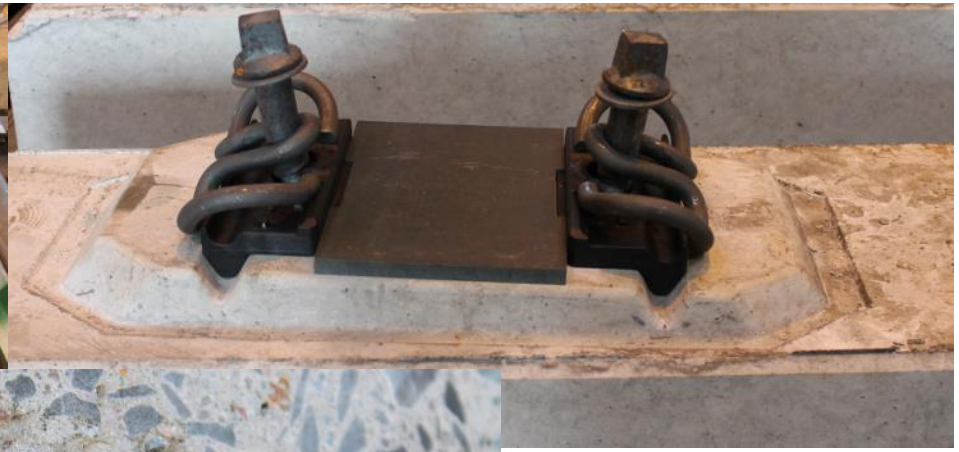
New features

- Elasticity of the turnout structure was modified with many different components, but the foremost change was to use the proper rail pads in every fastening.
- Other new features was under sleeper pads, angle guided plates, new bearer design and also hollow bearers for actuators etc.



New features





Monitoring of the turnouts

- Turnouts have to be actively monitored to make sure that the new features really improves the behavior of the overall system.
- University started the monitoring right after the turnout installation in both places. With these sensors it is possible to analyze the behavior in short and also in long time span.
- New components has the main influence on vertical elasticity of track so monitoring was clearly focusing on measuring the vertical deflections.

Sensors

- Three turnouts (1 old and 2 prototypes) with the same measuring equipment

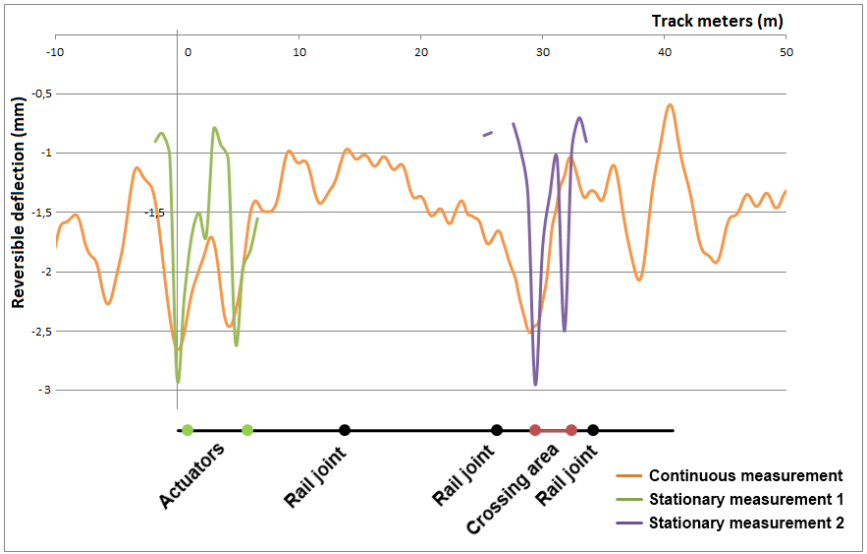
- **Vertical movement of rail compared to bearers**
- **Vertical movement of bearers compared to substructure**
- **Temperature inside the hollow bearers**
- **Axle loads**
- Movement of the actuator rods (Kouvola)
- Force of the actuator rods (Kouvola)

- All of these are measurements done in some defined points, but together with these also continuous measurements of track geometry and deflection was made (Stiffmaster and RAMI-wagon).

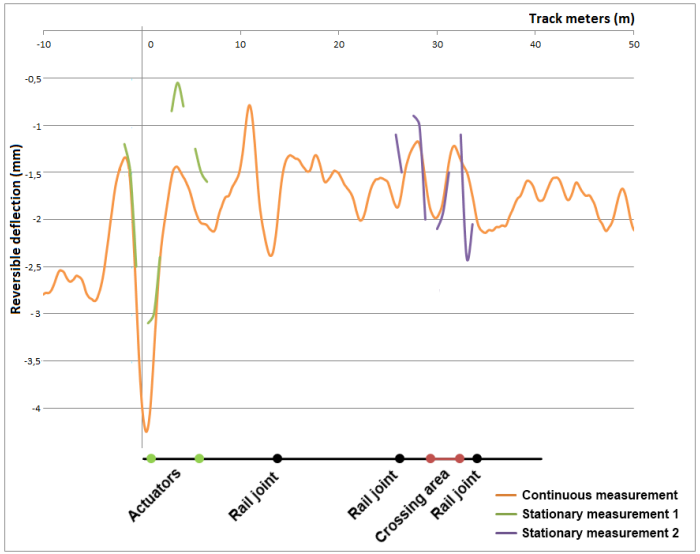
Behavior of the current structure

- Examples of reversible deflection during train passage..

Taavetti V413 (3 years after installation)



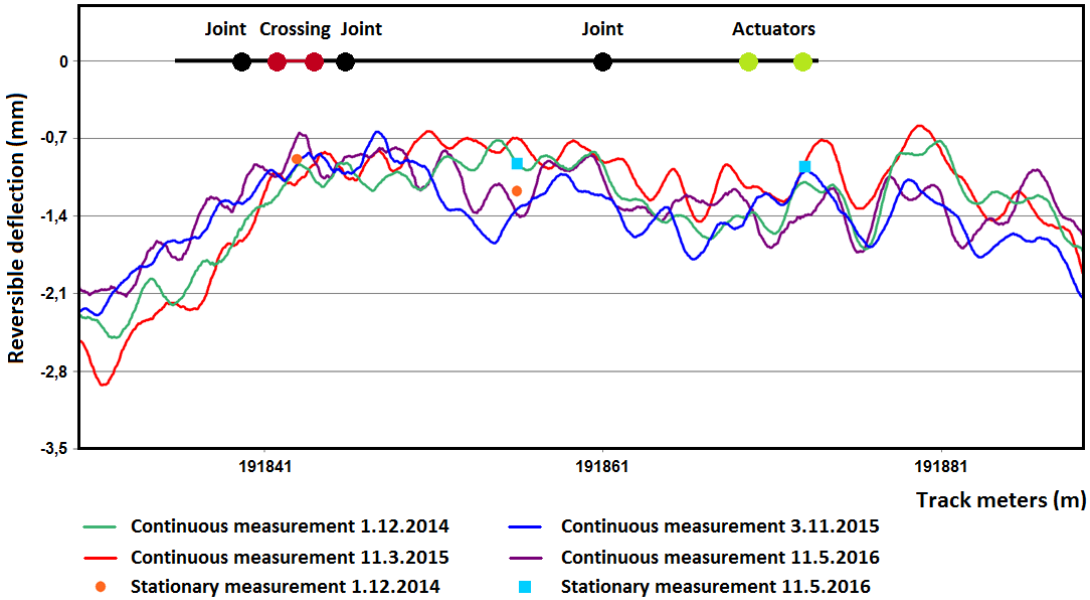
Tampere V051 (13 years after installation)



Behavior of the new elastic structure

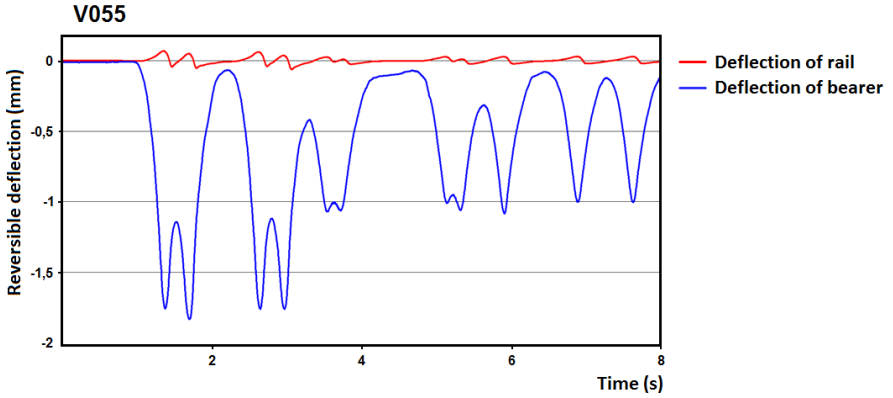
- The new structure and the decent tamping procedure leads to situation where the reversible deflection is smoother and there is no single weak points.

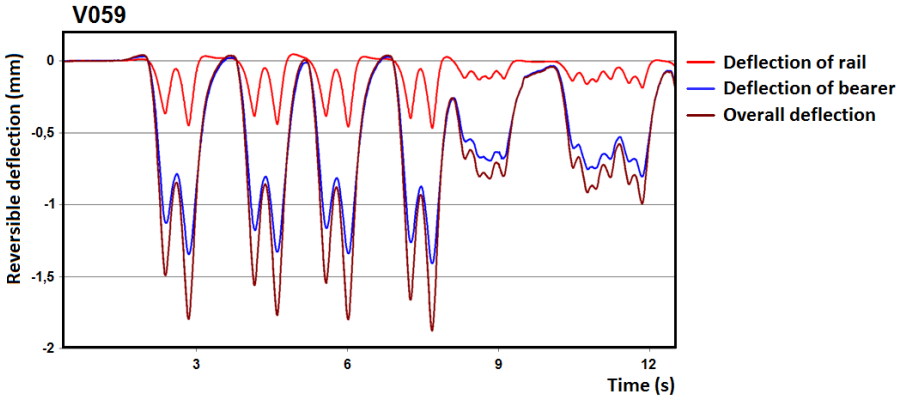
Kouvola V059 (first 2 years after installation)



Movement of the rail and bearers

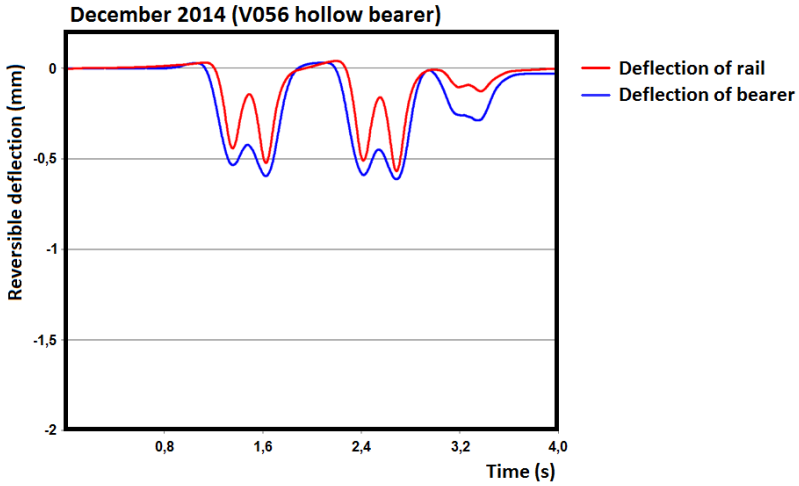
- In current structure the rail basically doesn't move compared to bearers which leads to situation where all the movements happens between bearers and substructure
- This naturally stresses the ballast layer which is not design to act as a elastic component
- In the new elastic structure, significantly part of the deflection happens between rail and bearer and that decreases the movement of the bearer.
- Total deflections are the same in both cases.

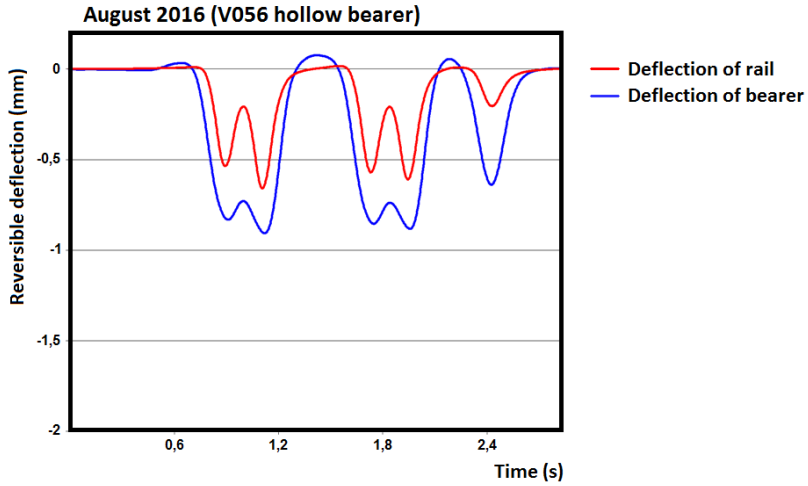




Changes in deflection

- Same sensors also enables the monitoring of long period settlement and changes in deflections
- Results shows that the deflection has only minor changes (< 0,5 mm) during the test period.
- Test period is still quite short so major conclusions about the future are hard to make





Conclusions

- The stiffness of the current turnout structure led to situation where FTA started to develop a new more elastic turnout structure.
- First prototypes were installed in Kouvola on 2014 and the next phase happened on 2016 in Oulu
- This new structure includes many new components which aims to distribute the loads more evenly to the ballast layer
- Tampere University of Technology has monitored these turnouts right from the beginning
- First results from Kouvola shows that the structure is working really well and it meets the requirements which are set in the beginning
- Results from Oulu are still under study and it is too early to make any conclusions..

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www.tut.fi/railway