A new small-scale test rig for the wheel-rail contact studies

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Motivations to build a new rig
- High costs of the rolling contact fatigue problem in the wheel and rail materials
- Unclear root causes of rail squats
- Uncertain relations between the microstructural and mechanical effects
- Difficulties in field tests/uncertainties in numerical/theoretical modelling
- Lack of similarity of tests to the reality
- No available test setup to simulate the impact-induced RCF

Design process of the new setup
Step 1: Literature survey on available setups for wheel-rail contact experiments
Step 2: Determine the operational mechanism of the new test rig by evaluating various methods
Step 3: Perform a dimensional analysis and determine the proper scaling strategy for the new rig
Step 4: Finite element analysis of the downscale test rig to finalize the concept design and dimensions
Step 5: Compare fatigue mechanism and cyclic behaviour of the new test rig with the real system
Step 6: Perform the detailed mechanical and electrical design of the setup → manufacture the new test rig

Step 2: Which operational mechanism?
- Full-size vehicle/bogie rigs
- Full-size wheel-on-roller
- Full-size wheel-on-straight rail
- Full-size wheel-bogie rigs
- Reduced-scale test rigs
- Scaled wheel on straight track
- Scaled wheel on rail track ring

Step 3: Dimensional/scale analysis
- Scaling of dynamic and impact loading
- Flexible scale from 1/5 (basic) to 1/7
- Having a rail-track ring with all components
- Including multiple (four) wheel components
- A spinning frame structure on a ring track bed fixed on the ground
- Adjustable loading conditions, driving and braking torques, frictional behaviours
- Flexible rolling angle and creep forces

Step 5: Fatigue similarity analysis
- Similarity in dynamic and impact loading conditions and rolling contact behaviours
- Similarity in stress-strain behaviours by using real materials of the wheel and rail
- Adjustable loading conditions, driving and braking torques, frictional behaviours
- Flexible rolling angle and creep forces

Step 6: Finalizing the concept design
- The final concept design
- Detailed design of the new setup
- The final built setup in the Lab, TU Delft