SUSTRAIL combined improvement in freight vehicles and track components

SUSTRAIL is a EU Framework 7 collaborative research addressing the theme: "The sustainable freight railway: Designing the freight vehicle – track system for higher delivered tonnage with improved availability at reduced cost". The SUSTRAIL project is a 4 years project that ended in May 2015.

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In the context of strong growth in road transport and a forecast growth in volumes of freight SUSTAIL's aim was to contribute to the rail freight system to allow it to regain position and market, aligned with a target of the European Commission. The project was undertaken by a balanced consortium of infrastructure managers (IMs), freight operators, companies involved in the rail sector, and academics.

SUSTRAIL considered a combined improvement in both freight vehicles (with a targeted increased in speed) and track components (for higher reliability and reduced maintenance), and also the interactions between them. A holistic approach was adopted; benefits to freight and passenger users (since mixed routes were considered) were quantified through the development of appropriate business cases to ensure profitability for all stakeholders.

Within SUSTRAIL it has been discussed the regulatory framework that any innovations in track or vehicle should comply with, particularly the six Technical Standards for Interoperability (TSI) relevant to the SUSTRAIL project and the UIC leaflets on standard construction measures and operating procedures. Also, due to the diversity of the European rail freight industry, thorough benchmarking studies were carried out at three diverse freight systems, operating on routes in Spain, Bulgaria, and the UK.

The SUSTRAIL business case was integrated into the project early on, with duty requirements defining what the rail industry needs and would benefit from (in terms of technical innovations in the vehicle and track) to meet the overall objective of increasing the traffic and market share of rail freight. The key technical innovations proposed within the project were assessed using: LCC (Life Cycle Cost), RAMS (Reliability, Availability, Maintainability, and Safety), and cost benefit analyses.
The duty requirements included: increasing freight operating speeds, reducing energy use, and reducing forces causing damage to the track. Other factors were also taken into account such as improved aerodynamics, environmental noise mitigation and easy integration with the existing fleet, maintenance procedures, and safety standards. The cost-benefit analysis included financial analysis of the impact on IMs, train operators, end users, and government and a socio-economic cost-benefit analysis covering all parties.
Since innovations cannot be considered truly useful if they are not implemented, it was also important to consider potential barriers to their implementation and demonstrate reasons to adopt them; part of this was considering the financial interface between IMs and freight operators.

'**Rolling stock innovations**' correspond tothe improvement of the vehicle design resulting in reduced operating costs for both vehicle and track, and reduced environmental impact. One of the main rolling stock innovations developed as part of the project was the SUSTRAIL freight bogie (patent pending). This was based on the established Y25 type bogie and incorporated the following innovative technologies:
• Double 'Lenoir link' primary suspension to improve the curving properties of the system and reduce damage to the track
• Interconnecting links providing lateral stiffness between the axle boxes (to improve running behaviour and reduce wheel wear)
• Noise reduction technologies: brake discs, and spring inserts
• Braking system: brake discs, redundant pneumatic back-up system, wheel-slide protection
• Condition Monitoring: weighing valves installed in the bogie for local load monitoring; electro-pneumatic braking control with diagnostic functionality; thermocouple and accelerometers on each axle box
• Power Supply: bearing generator with battery back-up and intelligent power management
• Reduced weight: use of high strength steels, and

The SUSTRAIL wheelsets including impact resistant axle coating

Source: thestar.com.my

optimised section designs
• Protective axle coating: to reduce the potential for fatigue cracks initiated by surface damage
Computer simulations were used to assess various combinations of the technology improvements and to establish critical speeds and optimal design parameters for the new primary suspension system. Other analyses and tests were carried out as appropriate: e.g. both ballistic tests and non-destructive tests were carried out on axles with and without the coating; finite element analysis of the bogie.

Regarding the vehicle structure, the project aimed to develop an adaptable, intermodal flat wagon, addressing three main design criteria: lightweight; increased capacity; and sustainable, low-cost solutions (including recycled materials and interchangeable components). The vehicle body used novel high strength steel grades and cold formed profiles, optimised spigot disposition, sustainable flooring materials, and lightweight covers. Other innovations that did not feature on the vehicle were studied as 'virtual demonstrators'. These included:
• Measures for reducing aerodynamic drag including logistics aspects of loading
• Options for locomotive traction
• Friction control: recognised to reduce environmental pollution, vibration, noise, and the cost of operation and maintenance; tests were carried out on the effect of friction modifiers in the contact zones of both wheel and rail, and wheel and brake shoes.
• Monitoring the structural integrity of axles (using low-frequency vibrations and acoustic emissions).
• Energy harvesting systems for powering condition monitoring equipment

'**Infrastructure Innovations**' correspond to the improvement of the resilience of the infrastructure system, reduce costs, and improve track accessibility. There was a strong link between this work and the vehicle work since the vehicle design directly affects track deterioration and vice versa. The work considered many aspects of infrastructure: rail, support (including ballast, transitions, and reinforcements), switches and crossings, and wayside condition monitoring. Innovations were selected by the infrastructure managers using a 'failure modes and effects analysis' (FMEA). Following this, a wide range of testing and simulation work was undertaken to produce models, recommendations, and procedures.

A few highlights:
• development of 'Minimum Action Rules' for corroded rail
• mechanical testing of insulated joints
• the use of advanced rail materials to combat wear and rolling contact fatigue
• testing of lubricants for slide plates
• optimisation of the support stiffness in the area of the crossing panel (under-sleeper pads)
• optimising transitions
• vehicle defects that can be detected by dynamic force monitoring and associated maintenance limits

The SUSTRAIL prototype vehicle has been built and laboratory and track tests were organised to establish the viability of the innovations.

As well as the SUSTRAIL prototype vehicle, four track innovations have been tested on mainline infrastructure:
• Premium rail steel
• Earthwork-stabilising geo-textiles with inbuilt monitoring sensors
• Under-sleeper pads
• Wayside monitoring of vehicles
Other innovations included modelling approaches and monitoring equipment that could reduce uncertainties and result in more robust maintenance regimes for track, switches and crossings, and associated structures.

During four years the SUSTRAIL project occupied almost 70 person-years of effort and has delivered significant advances toward achieving a sustainable freight railway.

SUSTRAIL assembled wagon

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