Sustrail: The Sustainable “Freight Vehicle-Track” system

A sustainable and efficient freight transport in Europe plays a vital role in having a successful and competitive economy. Freight transport is expected to grow by some 50% (in tonne-kilometres) by 2020 when more freight and more passengers will have to travel by rail to meet Europe’s short, medium, and long-term traffic needs. In this context, rail transport is unique in its complexity. It is the only transport sector that must consider the vehicle, the transport medium (e.g. the track), and the network (flows, regulations, procedures) in parallel. Rail transport is also unique in the diversity of operating procedures, codes, regulations, guidelines, and business models across EU member states. Change for the rail industry is both necessary and opportune. Within this framework, the EU project SUSTRAIL funded in June 2011, aiming at contributing to a new era in the rail freight sector by adopting a holistic approach, implementing a clear methodology and viable procedures for a combined improvement in both freight vehicles and track components.

Project objectives

The expected benefit from the SUSTRAIL project is an increased performance of the whole rail freight system (vehicle plus track), which would be obtained and assessed through the implementation of appropriate life cycle cost analyses. SUSTRAIL will therefore promote modal shift of freight in Europe from road to rail, providing the appropriate characteristics of the infrastructure. This made it possible to define the whole rail freight system (vehicle plus track) configurations: ‘Conventional’ (optimised with respect to existing) and ‘Futureistic’ (technologies not yet been proven in the railway field). Moreover, on the other side of the wheel-track interface, performance-based design principles and complementary monitoring tools are identified which can increase reliability and safety levels of the infrastructure. Achievement of this goal will assist the infrastructure managers to move towards the zero maintenance ideal for the track system. Business cases have been set up to demonstrate on real routes the contributions, solutions and innovations SUSTRAIL is aimed at introducing in the railway sector. In what follows, the major achievement of the project, that has recently made its halfway point, are presented divided by areas of activity, namely:

• Benchmarking, assessing the freight system on selected routes and throughout Europe;
• Duty requirements for the freight-track system;
• Freight vehicle;
• Infrastructure;
• Business case;
• Technology demonstration.

Duty Requirements

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The freight vehicle of the future

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.

The work carried out in SUSTRAIL with reference to the vehicle aims mainly to come up with solutions for freight vehicle innovation at two different levels.

• An “improved conventional” vehicle design optimising existing technology and a demonstrator for this is being built as part of the project.
• A study for a “futureistic” design of a sustainable freight bogie utilising technology which has not yet been proven in the railway field but has great potential.
Sustainable track

Building upon the duty requirements, optimising track design and maintenance approaches to move towards the ‘zero maintenance requirement’ ideal is a further issue SUSTRAIL is working on. Increasing track component life, improving condition assessment/monitoring and reducing maintenance activity will all play a part in increasing capacity and speed whilst reducing costs. The contributing factors making rail freight more competitive and sustainable. Track failures have been identified and ranked by means of a Failure Mode and Effect Analysis (FMEA) to determine where to focus activities. This has been undertaken with the project Infrastructure Managers to ensure issues specific to their unique operating environments have been included in the analysis. The outputs from the FMEA have resulted in a number of solutions being considered for further investigation and will also support whole life analysis by the business cases.

The FMEA was carried out with the aim of moving from deterministic to probabilistic (e.g. performance-based) analysis. This means that random variables defined by means of statistical distribution combined in stochastic process are being considered in the design of the track aimed at carrying out a full reliability-based analysis, the FMEA constitutes the initial steps. Furthermore the adoption of performance-based design methods accounts for the behaviour of a component/system across a certain time frame (life cycle) that is fundamental in terms of maintenance tasks. Indeed, estimating the changes of a component/system across its lifetime allows the adoption of condition-based and predictive maintenance approaches whose aim is to minimise the need for unscheduled operations, thus lowering the number and impact of maintenance tasks. Moreover, a performance-based design approach allows the investigations of track upgrades that SUSTRAIL is proposing, since they can be proven in a life-cycle perspective.

The SUSTRAIL Business Case

Building upon the prioritisation of duty requirements, and the identification of innovations and upgrades identified in both freight vehicles and infrastructure, business cases are being implemented aiming at proving, on a qualitative and economical basis, the potential costs and benefits for end users of the proposed SUSTRAIL innovations. Recommendations for whole system implementation, including phasing-in of novel technologies and strategies for the equitable redistribution of whole system savings will also be provided. The business case will be finalised towards the end of the project (May 2015); however, six main scenarios have already been identified as shown in table 2.

For the purpose of developing the analysis tools, a set of starting assumptions was made about the impacts of the SUSTRAIL vehicle innovations, including: a 5 % reduction in track access charges following a reduction in dynamic forces and in track damage; a 10 % improvement in reliability measured by train delay per track-km; a 7.5 % reduction in journey-time-related costs; a 20 % reduction in fuel cost for a given load; a reduction in wagon maintenance and non-fuel operating costs of 10 %; and a reduction in emissions factors for rail by 20 % matching the reduction in fuel consumption. A key element of the business case is the assessment of Technical Implementation and Phasing. A literature review is being prepared which addresses the state of the art to human factors issues and operational issues arising from the integration of novel vehicles and track systems into the existing railway. The expected outputs in this sense will include:

- the projected time profile for introduction of the new vehicle into the European mixed-traffic network from 2015 onwards.

Technological Demonstration

SUSTRAIL upgrades and innovations will be tested and demonstrated in full-scale tests in Romania at the Făurei test centre operated by the Romanian Railway Authority (AFER). The testing centre, established in 1978, consists of:

- a large ring featuring the following characteristics:
  - 13.7 km with 6 four-leaf bridges and 4 level crossings;
  - maximum speed of 200 km/h;
  - electrification in single – phase alternating current of 25 kV/50 Hz with the level of catenary at 5,5 m;
  - a small ring featuring the following characteristics:
    - 2.2 km with 3 four-leaf bridges;
    - maximum speed 60 km/h;

Initial telemetry tests have been carried out to set a benchmark against which the SUSTRAIL innovations can be compared. A reference test vehicle was used (an EAOs Ordinary open high-sided wagon, UIC 571-2) and the following tests carried out: braking system testing, noise level measurements, wheel profile measurements, track measurements including track and rail profile measurements. The same testing will be carried out on the SUSTRAIL upgraded track.

Conclusions and Outlook

The SUSTRAIL FP7 research project (www.sustrail.eu) “The sustainable freight railway: Designing the freight vehicle-track system for higher delivered tonnage with improved availability at reduced cost” aims to improve the performance of freight rail. SUSTRAIL will implement a combined approach to innovation in rolling stock by developing advanced vehicle component and subcomponent concepts using innovative materials and production processes. Reliability-based design will be employed aiming at reducing uncertainties, optimising maintenance activities and thus reducing life-cycle costs of a typical railway system. Finally, SUSTRAIL aims to deliver the ideal combination of novel freight vehicle design coupled with novel sustainable track concepts with respect to the project core pillars of sustainability, competitiveness, and availability.

Sustrail: Устойчивый “Грузовой автомобиль-рельсового пути” системы

Устойчивый и эффективный грузовой транспорт в Европе играет жизненно важную роль в том, успешен ли конкурентоспособный экономика. Грузовые перевозки как ожидается, варианте примерно на 50 % (в тонно-километрах) в 2050 году , когда большие грузов и более пассажиров будет путешествовать по железной дороге для удовлетворения спроса Европы средних и долгосрочных потребностей. В связи с этим, развитие транспортной системы является уникальные по своей сложности... Это сложный сектор транспорта, к которым должен рассмотреть автомобильное транспортное средство (латор, грузов ) и сети (конечных, полезных, процедур ) параллельно. Железнодорожный транспорт также является уникальным во всем многообразии операционных норм, правил, управленческих принципов и бизнес-моделей по “чэнс” ЕС. Недостатки для железнодорожной отрасли являются необходимым и конструктивным. В рамках этого проекта EC SUSTRAIL был запущен в июне 2011 года, направленный на содействие новой и в секторе железнодорожного грузового перевозки принятие всеобъемлющего подхода, инновационной методики и жизнеспособные процедуры для комбинированный углубленное и общей грузовой транспортным средствам и отслеживать компонен...