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ADVANCEMENTS IN THE FIELD OF RAILWAY VEHICLES

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1. INTRODUCTION

This paper presents a number of recent developments in the area of railway vehicle design. These innovative solutions are mainly the products of research projects and have the potential to improve the performance of railway vehicles through, for example, reduced forces on the track or improved ride comfort or resistance to derailment.

2. ACTIVE SUSPENSION

Active suspension as a concept is not new. The components required for an active suspension are now established and widely used in many industries. Partly due to the harsh environment and the conservative nature of the railway active suspension has not been widely adopted although some ‘slow active’ systems such as air spring secondary suspension or tilting of car bodies in curves are widely used [1].

In the recent ‘FORESEE’ project [2] a two-axle vehicle was fitted with forced radial steering using slow active pneumatic actuators and full active primary suspension provided by permanent magnet linear motors and associated controllers. This relatively simple active suspension system has been tested and shown to provide good stability with low track forces compared with a conventional two axle vehicle.

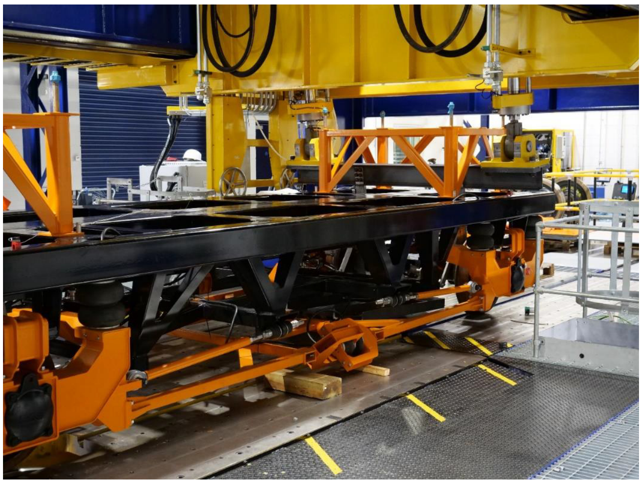

Fig. 1. The FORESEE vehicle

3. NOVEL MATERIALS

Railway vehicle running gear is traditionally constructed from cast and fabricated steel components. Although steel provides a high level of reliability and is well understood there are now many ‘modern’ materials and novel manufacturing methods that offer possible improvements. For example composite materials including fibre reinforced plastics have been used for over 50 years in other transport modes. Carbon fibre reinforced materials offer very high levels of strength to weight and this means that suspension components can be constructed with the required strength in the right places but with much lower mass than steel equivalents.

An example of the use of composite materials in railway vehicle running gear is the ‘CaFiBo’ Carbon Fibre Bogie project in the UK [3]. In the CaFiBo project a prototype bogie has been constructed from recycled carbon fibre material resulting in a bogie meeting all the performance requirements of the equivalent steel bogie but with less than 50% of its mass. This bogie is currently on test at the University of Huddersfield.

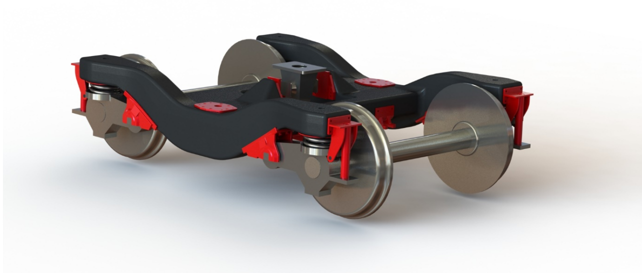

Fig. 2. The CaFiBo carbon fibre bogie

Even greater benefits can be derived from composite materials if the inherent flexibility of the materials can be included in the design of the running gear. This would potentially mean that springs and dampers could be incorporated into the bogie structure.

Other potential material developments include the use of additive manufacturing (previously known as 3D printing). Additive manufacturing allows complex

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shapes to be constructed and, if carefully designed, this means that lightweight components can be constructed with geometries that are precisely tailored to the requirements of the structure and to provide the strength and flexibility required in each direction.

4. BARRIERS

The examples above have shown that innovations in a number of areas have the potential to improve the performance of railway vehicles but there are barriers to their adoption. These include higher initial cost and non-standard failure modes. A key challenge to railway engineers is to be able to build a business case so that manufacturers and investors can adopt the innovations. Tools that will help this are life cycle costing so that higher initial costs can be compensated by lower operation or maintenance costs. Another challenge can be to ensure that benefits in one part of the system are shared across the whole system. For example an improved suspension that results in lower track forces and corresponding reduced track maintenance costs must give benefits to vehicle operators through reduced track access charges.

5. CONCLUSION

There are several innovations that are close to being adopted within the running gear of a railway vehicle. These innovations including active suspension and novel materials have the potential to improve the dynamic performance of the vehicle but there are still significant barriers to be overcome. Further work on ensuring that the benefits can be realised by the vehicle operators is still required.

REFERENCES

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