IWC delegates were able to visit the Trenitalia high speed train maintenance workshops in Vicenza.

Understanding **wheelset** behaviour

Automated inspection systems and condition-based maintenance were core themes at the 19th International Wheelset Congress. Chris Jackson reports from Venezia.

The fourth industrial revolution based on data and automation is changing the way in which wheelsets are designed, manufactured and maintained, and digitalisation was a key thread running through this year's International Wheelset Congress in Venezia.

Organised by the European Railway Wheelset Association, the 19th IWC drew several hundred delegates from across the sector, including manufacturers, operators and maintainers, as well as research institutes and regulatory authorities.

Meeting in the impressive surroundings of a former monastery on the island of San Giorgio Maggiore, congress delegates discussed many aspects of wheelsets, from materials development and manufacturing through qualification and certification to service performance, inspection and maintenance. There were also papers on the development and integration of other wheelset components including bearings and brakes, to create 'an integrated system'.

Welcoming delegates as Chairman of the European Railway Wheelset Association, CAF Miira Managing Director Jon Aguirre emphasised that IWC had become a platform for the industry to share experience across the whole rail sector, from heavy haul and high speed to urban and regional applications, discussing new ideas and trends while seeking to learn from each other. UNIFE Director General Philippe Citroën added that it was an important time for the European rail sector in particular, with the entry into force of the technical pillar of the Fourth Railway Package helping to consolidate the safety approval and authorisation processes and reduce costs.

Harnessing big data

Discussing broader stakeholder expectations in the opening round table, Stefan Geisberger from DB's rolling stock maintenance business DB Fahrzeuginstandhaltung warned that intermodal and on-rail competition were putting pressure on train operators to reduce their costs, and this was working through to the maintenance sector. Estimating that maintenance accounted for around 10% of operating costs that average €15 per train-km, he said his organisation was looking to harness big data to plan its work more effectively, and considering the scope to automate more processes in the face of a growing shortage of skilled technicians.

However, he emphasised the need for better data analytics, suggesting that his organisation was not alone in needing to make better use of existing data. Pointing out that 'we are already collecting tonnes of data' about wheelset condition, from profile measurement to bearing temperature, he said DB was still 'struggling to get the right information' which could add value and help it plan its workloads efficiently.

As chairman of the conference technical committee, Trenitalia's Chief Technical Officer Marco Caposciutti agreed that diagnostics was a key issue for all railways, because the trend towards fitting more and more sensors

The opening plenary session at IWC 2019 included a round-table debate on the changing expectations of the rail sector.

Photos: IWC/Daniel Nardelli

on vehicles and in lineside monitoring stations was generating huge quantities of data. However, he noted that industry responses to warning alerts might differ. Whereas an infrastructure manager's first reaction might be to stop a train with a deteriorating wheelset, the operator might want to keep going, in order to minimise inconvenience to its customers and preferably get the train back to a workshop.

Philippe Citroën commented that the pressure for train operators to reduce costs was one of the factors behind the intention to emphasise maintenance in the proposals for the next Shift2Rail research programme. However, he reminded delegates that Europe's MEAT principles for 'most economically advantageous tendering' already allowed procurement on the basis of whole-life costs, spending more up front to buy quality products that would need less maintenance in future.

High speed inspection

Reflecting the current trend among European infrastructure managers to install advanced vehicle inspection systems, Wolfgang Zöttl of ÖBB-Infrastruktur described the OBAL measuring site that has recently been commissioned in the Wienerwald tunnels west of the Austrian capital. Using equipment from MerMec, this measures wheel profiles and wheel-rail forces at speeds up to 250 km/h. The collection of field data at two separate sites approximately 2 km apart allows the infrastructure manager to identify any out-of-roundness, while correlating wheel condition and running stability for all passing vehicles.

Recognising that vehicle riding behaviour is strongly influenced by the wheel-rail contact geometry, the stability monitoring site is located on a straight section of track, and uses sensors clamped to the standard running rails, rather than special measuring rails. These sensors assess vertical and lateral dynamic forces as well as the wheel shape. Raw data is transmitted via redundant data cables to a measuring and evaluation station at the tunnel portal, close to where the wheel profile measurement system is located

Having successfully calibrated the equipment with a variety of test runs, ÖBB-Infrastruktur is now starting to collect live data which it hopes will provide a critical mass for future analysis.

Condition-based maintenance

As an example of what can be done, Trenitalia is currently undertaking a fleet-wide trial with its Vivalto double-deck push-pull trainsets, looking to move from a strict mileage basis for wheelset reprofiling to a condition-based model determined by regular monitoring of wheel profiles.

Chiara Triti from the operator's Technical Department explained that the greater availability of diagnostic data had allowed Trenitalia to extend the reprofiling intervals, by checking the flange dimensions, equivalent conicity and wheel tread roll-over each time the mileage limit was reached.

Comparison between the Vivalto fleets used in four different regions had confirmed that wheelset life was closely related to the 'mission profile', and the geometry of the route over which the trains operate. Wear mechanisms were markedly different for largely straight and heavily curved routes, she reported.

Trenitalia has developed an algorithm to assess whether a fixed-distance extension to the reprofiling interval should be granted, based on the residual life of wheelsets in a given bogie. The next step will be to develop this further to take account of the vehicles' planned deployment and local route geometry to provide a better prediction of wheel deterioration and enable the fine-tuning of maintenance intervals.

Meanwhile, Göteborg-based Charmec is working with Trafikverket and SJ on the assessment of data from measuring stations in northern Sweden to address the wheel damage encountered in severe winter weather. The digitalisation of condition monitoring data is providing an input for simulation and evaluation of wheel fatigue models, differentiating between mechanical damage such as wheel flats and rolling contact fatigue.

Deep learning vision

Machine learning is expected to play a greater role in diagnostics, and China Academy of Railway Sciences is exploring the potential use of Convolutional Neural Networks to speed up the assessment of bearing condition on high speed trains. Researcher Hu Xiaoyi explained that axlebox vibrations are already monitored to assess the condition of roller bearings, but the 'intelligent diagnosis' is largely based on pattern recognition to identify and classify the fault signatures extracted by signal processing.

To reduce this dependence on signal processing technology, CARS has been looking at a deep learning approach that could combine fault feature extraction, classification and recognition in a single model. Using laboratory and roller rig testing, the model has been taught to 'learn' fault features from the raw data under controlled conditions. The next step will be to trial the concept on high speed EMUs operating in revenue service, which Hu said would begin 'in the near future'. ■

10%

OF OPERATING COSTS ARE ACCOUNTED FOR BY MAINTENANCE, ACCORDING TO AN ESTIMATE FROM DB FAHRZEUG-INSTANDHALTUNG

STANDARDISATION

AAR adopts new wheel profile

With effect from the beginning of 2020, the Association of American Railroads will standardise on a new wheel profile for all wagons used in interchange service across North America. Scott Cummings of Transportation Technology Center Inc explained to IWC delegates that the AAR-2A profile is intended to replace the AAR-1B profile which has been the industry standard since 1990.

TTCI has been working on development of the AAR-2A profile since 2004, undertaking extensive analysis, simulation and testing, both at Pueblo and in revenue service under a variety of wagon types. The new profile is designed to provide a nearly conformal contact with a typical rail on the high side of a curve, offering improved curving performance and reduced rolling resistance, which in turn reduces fuel consumption. It will also help to lower wheel and rail wear and surface damage.

According to Cummings, the AAR-2A profile contains more material in the flange root than the AAR-1B, in order to reduce the strong two-point contact experienced when the wheel makes flange contact with a typically worn high rail in a curve. This is expected to reduce the high level of flange wear typically experienced with the 1B profile in the first 40 000 to 160 000 km of operation. It also offers a more even distribution of wear across the wheel flange and tread, such that the profile does not change significantly during the service life of the wheel.

Modelling with TTCI's Nucars vehicle dynamics simulation software was used to compare the curving and hunting performance of the two profiles, after which the AAR-2A was initially tested on a five-section articulated double-stack container wagon. In-service trials were then undertaken with small batches of coal wagons and covered hoppers.

After reviewing the results, the AAR-2A profile was adopted as an 'alternate standard' for reprofiled wheels in September 2016, and for new wheels from October 2018. Once it has been adopted as the primary standard in January, the AAR-1B profile will gradually fall out of use as existing wheelsets are reprofiled or replaced. ■

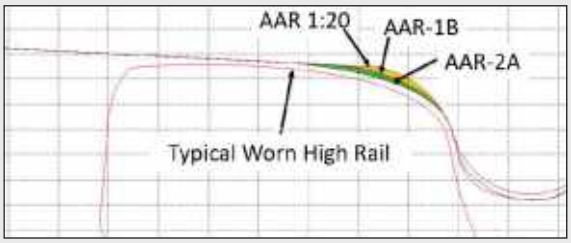

Fig. 1: The AAR-2A profile is intended to improve conformal contact with worn rails compared to the earlier AAR-1B.