Trimming the cost of track inspection

**MONITORING** Gaining access to busy tracks to check for defects is increasingly difficult and expensive, but legislation such as the Railway Safety Directive in Europe enforces the effective monitoring of both infrastructure and rolling stock. Cheaper alternatives to conventional track inspection methods are starting to emerge, finds Murray Hughes.

**Divison of traditional railways into operating and infrastructure companies** has tended to exacerbate the divide between the management of rolling stock and fixed assets, although even in national railways the responsibilities were often split between different departments. It can be argued that the split stemmed partly from a lack of hard evidence or data to support the underlying dependence between the behaviour, or deterioration, of the two groups of assets, despite the fact that it was common knowledge among everyone involved that track and trains were indeed inter-dependent.

Today, there is growing recognition of the interaction of track and trains in terms of wear and deterioration, and in some cases senior management recognises the benefits of an integrated approach. On heavy haul railways, for example, co-operation is generally implicit, with the chief engineer holding responsibility for both track and trains.

**Legislative framework**

Monitoring the condition of infrastructure and rolling stock becomes more significant under the European Union’s Railway Safety Directive. Responsibility for ensuring that safety is maintained now rests with the infrastructure manager, the operator, the vehicle owner, the ‘keeper’ or technical manager of the vehicle, and also with the person or organisation responsible for loading it. All have tasks and responsibilities laid down in national and international legislation as well as in regulations and private contracts.

Fulfilling these different tasks without incurring disproportionate cost will increasingly rely on remote monitoring of the status of the asset, be it track, catenary or rolling stock — and its interaction. This brings into play infrastructure measuring equipment as well as automated wayside measuring systems.

Track inspection trains or single inspection cars have been widely used to measure numerous track parameters and ensure that they remain within specified tolerances, either for reasons of safety or for ride comfort. In some cases the trains run at similar speeds to commercial traffic, and among the most sophisticated vehicles in service are the Doctor Yellow trainsets in Japan, RFI’s Archimede in Italy and Network Rail’s New Measurement Train in the UK.

Inspection vehicles collect huge amounts of data. This can be processed on board, stored for later downloading or transmitted to a remote processing centre. The resulting information is used to determine if urgent maintenance or repair work is required and also to plan maintenance in the short or long term as well as to check the effectiveness of previous intervention. Infrastructure managers can use the information to build a detailed picture of the state of track and related equipment across the network, allowing trends to be identified and
troublesome spots to be monitored.

As an example of what is now possible, the latest optical and video equipment produces high-resolution or three-dimensional images which modern software can analyse automatically for anomalies or defects. Pietro Stama, Operational & Strategic Marketing Director at MerMec Group in Italy, says the use of company’s ‘vision technology’ allows automatic identification and inspection of assets. V-Cube, for instance, allows up to 26 types of track defect to be automatically detected and measured. When correlated with other available data, this allows better analysis of defect causes and enhanced condition-based maintenance.

Remote inspection option

The disadvantages of dedicated inspection trains or individual vehicles include high capital cost and the occupation of paths that may otherwise be available for commercial traffic. Not only that, but specialist staff are required to operate the trains and maintain the monitoring equipment.

In practice, only relatively large railway organisations can afford their own inspection trains, but pressure on costs has prompted a search for alternative methods to inspect track and other infrastructure at lower cost.

While smaller operators often outsource inspection activities or rely on manual devices, the option of remote or unattended inspection systems is of growing interest. These can be fitted to trains running in revenue service, something which has become possible thanks to improvements in electronics, component reliability and wireless technology. Small components allow measuring equipment to be installed in bogies with links to compact processors that are easily accommodated within a locomotive, passenger vehicle or wagon.

So far, relatively few train operators make use of remote monitoring, partly because of a lack of awareness of the benefits, partly because of considerations relating to the return on investment, and partly because the present technology does have operational limits — among the concerns are data validation and precise determination of the location of defects, so-called localisation. However, according to Stama, the measurement results from remote monitoring systems ‘are comparable to those of dedicated attended measuring cars’.

Advantages

Stama cites numerous advantages from the use of remote equipment. These include a dramatic increase in inspection frequency and a significant reduction in operating costs. Data is available as often as the host vehicle runs over the track. Frequent operation over dedicated routes, and the resulting regular flow of measurement information, ensures that managers and engineers are supplied continuously with up-to-date condition reports.

Remote inspection also provides warnings of sudden changes in the infrastructure and allows the rate of deterioration at any location to be monitored, enabling a more accurate prediction of when track components will need replacing. Taken a stage further, it becomes possible to calculate the different rates of deterioration for various types of asset, setting the stage for a move from corrective to predictive maintenance.

For example, MerMec’s RAMSYS decision support tool adopts infrastructure deterioration modelling and whole-life asset management principles to allow optimised activity planning and control, supporting condition-based/predictive maintenance and renewals.

Another benefit is that immediate feedback is obtained about the quality of track maintenance work.

Stama says that several types of unattended measuring equipment can now be installed on a ‘plug and play’ basis. The equipment includes a self-localisation facility and automated recovery should the data acquisition process be interrupted. Self-diagnosis in the case of faults in the monitoring equipment or data transmission is also possible.

To date, the most common applications of MerMec’s remote inspection equipment cover track geometry, rail profiles, rail corrugation and ride quality, but it is also used to check overhead line geometry and wear. Users include RATP in France, Canadian Pacific Railway, Taiwan High Speed Rail Corp and Network...
Remote monitoring is also being tried in the USA. Whereas the Federal Railroad Administration uses a fleet of dedicated geometry cars to inspect around 50,000 km of track every year—with plans to step up inspections to reach 160,000 km a year—other organisations are experimenting with various forms of unattended monitoring. Union Pacific has 22 ultrasonic rail flaw detection vehicles which were joined five years ago by a pair of EC-5 track geometry inspection cars supplied by Plasser & Theurer.

More recently, UP has fitted remote monitoring equipment on 10 locomotives and on a coal hopper to check the condition of its busiest coal routes. Supplied by Ensco, the equipment monitors vehicle-track interaction in order to detect deviations from normal behaviour that may be caused by track defects. High vertical impacts, for example, may be caused by problems at rail joints or by other forms of rail damage. The equipment was successful enough for UP to plan an order for another 10 units, nine of which would be fitted to locomotives and one to another coal car.

Experience

The UK is one country where remote inspection has been applied successfully, and several systems have been installed in revenue vehicles. In the case of MerMec equipment, the inspection devices automatically collect and transfer track geometry data in the form of a series of raw data files via wi-fi to network access points in stations. From these access points, data is passed via the internet to a file server located in Network Rail’s data centre in Derby, where MerMec has provided software that automatically detects the arrival of new data files from the vehicles and converts the raw instrument data into track geometry measurement files.

Network Rail also uses equipment from DeltaRail, which has supplied its TracklineTwo unattended track geometry recording equipment. One set was fitted for a year of trials on Network Rail’s New Measurement Train, and during October 2010 this was being used to collect data on the main line network while the train’s track recording coach underwent maintenance for four to six weeks.

Recording various parameters using non-contact optical and inertial-based equipment, TracklineTwo consists of two bogie-mounted instrumentation pods with high-precision cameras and dual laser technology. The data is passed to a processor hub that can be accommodated under a seat or in a luggage rack, and this is then sent via wi-fi or other means to an office-based asset management system.

Another TracklineTwo package fitted to a multi-purpose test vehicle used by Network Rail is intended primarily for inspection of switches and crossings and tracks in depots. The same vehicle also has a video inspection pack. Adrian Golby of DeltaRail confirms that the technology of remote inspection is ‘still in its infancy in terms of moving away from track recording cars, and this is quite market dependent.

‘The first generation of remote track geometry inspection systems have in some cases proved disappointing in reliability and performance, but DeltaRail has now made significant steps in improving performance and reducing maintenance and calibration requirements through the integration of the necessary subsystems into its robust modular inspection pods and processor. This should stimulate the development of the market for remote inspection systems.

Pointing out that some railways do not make regular track inspections at all, Golby says that remote inspection poses the problem of handling huge amounts of data, suggesting that this may be a deterrent to wider adoption of the technology.

DeltaRail therefore provides an integrated suite of products including TracklineTwo, the TrackMaster maintenance support system and the Vampire vehicle dynamics modelling tool, to collect and transform data into useful information. The integrated capability can be used to predict degradation, identify trends in track geometry and develop maintenance plans. In some cases savings of up to 40% of tamping costs have been reported, the company says. Golby says the objective is to help reduce maintenance costs by turning data into information that adds value.

Remote inspection equipment can be installed on any type of vehicle, and an ‘add-on’ inspection module has been fitted to a multi-purpose track and overhead line maintenance vehicle supplied by Windhoff Bahn- und Anlagentechnik for use on High Speed 1 in the UK. A similar track inspection module has also been installed in a Windhoff multi-purpose maintenance vehicle operated on the UK’s West Coast Main Line.

Some of Windhoff’s latest multi-purpose vehicles have been designed specifically to accept inspection modules, and the company is keeping a close eye on developments in several countries.

Raildiagnostics of Ferrara in Italy is another supplier of video track monitoring systems.
inspection equipment that can be installed on any vehicle. Products include the Optotrack six-camera/laser system to measure rail profile and wear as well as corrugations, alignment, gauge, twist and cant.

There seems little doubt that remote inspection is becoming more widely accepted, but as Golby asserts, the railway industry remains conservative and a change such as this is bound to take time. MerMec goes as far as to say that remote monitoring will soon become a ‘commodity’ with monitoring systems routinely ‘embedded’ in rolling stock.

**Inspection wagon option**

This view is not universally held, however, and Eurailscout Director Aad van der Zouwen believes that use of a conventional inspection train or specialist vehicle is preferable to remote monitoring. He considers that sensitive track recording equipment is too specialised to be entrusted to the harsh environment of commercial operations, adding that access to the equipment for maintenance may also be more difficult.

Based at Amersfoort in the Netherlands, Eurailscout offers infrastructure inspection and analysis services right across Europe. It uses inspection trains such as the UST02 and UST96 to measure track and rail condition at up to 100 km/h. More recent vehicles such as the UFM160 can take measurements while operating at 160 km/h.

Eurailscout’s range of measuring equipment includes video for track defect detection, laser-based optical and inertial systems for track geometry measurement, laser equipment to identify rail corrugation, ultrasonic devices for detection of rail damage such as squats or split heads and inductive eddy-current tests for head check detection. Ground-penetrating radar is also available to check ballast condition and to identify wet spots.

Given that outsourcing inspection services is cheaper than purchasing dedicated inspection cars, Eurailscout’s vehicles see service in many countries, with one inspection train visiting Belgium, Germany, Norway, Slovenia, Switzerland and Turkey, for example.

Nevertheless, as van der Zouwen points out, the cost of a train fitted with signalling and train control equipment for use in different countries is high. A lower-cost alternative on offer is the MUV unmanned two-axle inspection wagon, the first of which was completed in time for display at InnoTrans in September. The MUV was due to be shipped to RFI immediately after the exhibition, and a second vehicle has already been ordered. Tests with a MUV have been requested in France, and two more inspection wagons are to be completed by the end of 2011.

The first MUV is intended to inspect switches and crossings, but it can also be used on plain line. With a 4 m wheelbase, it is designed to be hauled by a locomotive at up to 40 km/h in measuring mode, taking measurements at intervals of 18 mm. Van der Zouwen says that once the locomotive crew has been briefed on operation of the wagon, no further intervention is required.

Fitted with laser and optical measuring equipment, the MUV collects data that is transmitted to Eurailscout’s headquarters for processing. According to van der Zouwen, the inspection wagon is small enough to be shipped to worksites by lorry, a cheaper option than obtaining approvals for a self-propelled inspection train to run through different countries. Another advantage is that the wagon can be converted for use on track of different gauges.

The next step, says van der Zouwen, will be to develop a version with ultrasonic inspection equipment, but this, he suggests, will require the presence of staff on board while the machine is operating.

**Road-rail vehicles**

Another option is to use road-rail inspection vehicles that only occupy the tracks while they are actually working. This service is offered by Zeta-Tech in North America, whose range of inspection systems includes hand-held devices such as TiefInspect for sleeper inspection and TrackInspect for track inspection.

The company’s TrackSafe real-time vehicle-track interaction safety analysis system can be used in conjunction with onboard track geometry measurement to identify locations where unsafe vehicle dynamic behaviour is generated. The equipment checks the basic parameters of gauge, surface, alignment, cross-level and twist against permissible tolerances, but it can also measure other parameters.

TrackSafe has the ability to simulate simultaneously the behaviour of several types of vehicle at different speeds. It uses the geometry measurements to generate response predictions for car body bounce, roll angle, pitch angle, vertical acceleration and vertical wheel loads, and these can be calculated for any individual segment of track. Using established thresholds for these values, response predictions are assessed to determine if the vehicle is well behaved, or if it exhibits adverse dynamic behaviour and derailment potential.

Having identified locations with high risk, Tracksafe can then allocate them a priority, giving maintenance managers the information needed to take decisions on the need for repairs or other action.