



## Statement

Railway engineers are understandably very conservative in the use of any new technology for train operations. Only proven technology with good track record will be used. Any change to the conventional equipment and methodology must be brought-in under a technically and commercially prudent manner.

Fibre Bragg Grating (FBG) technology has been widely adopted in smart structure engineering with good records. An in-depth review on the FBG characteristic revealed that it can bring massive benefits to railway operation by giving additional train operational information to rolling stock engineers and signaling engineers in the monitoring and planning of the train traffic.

# RAILWAY

## MONITORING APPLICATIONS

**Fibre Bragg Grating (FBG) sensors are finding increasing applications in smart structures. They can be embedded in civil structures such as bridges, buildings etc. for the detection and monitoring of parameters such as strain, pressure and temperature. It allows assessments on the integrity of structures at various manufacturing and construction stages, and facilitates health management of many important structures in their subsequent operations. However, their application in railway engineering is rare.**

The need for improvement in safety and reliability will continue to be the most important issues of the railway industry. A smart condition monitoring system would allow real-time and continuous monitoring of the structural and operational conditions of trains. It could monitor the structural health of rail tracks and the location, speed and weight of passing trains of the entire railway system. Ultimately, the inclusion of train location, speed restrictions, and train and track conditions to the 'intelligent systems' will herald a safer railway industry with low maintenance cost, optimal performance and maximum capacity.

Fibre optic sensors offer many advantages over electrical sensors. These include immunity to electromagnetic interference (EMI), long life-time (>>20 years), fast response for the realization of smart condition monitoring systems for the railway industry.

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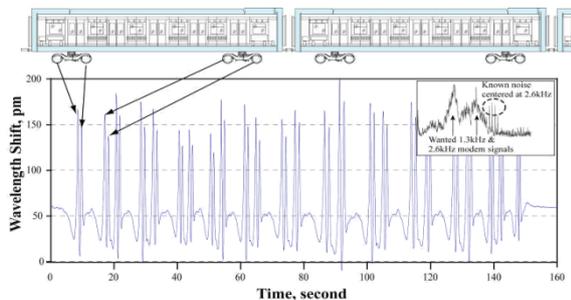
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## AXLE COUNTING

FBG sensors can be readily installed on the left and right rails (for the two wheels of the same axle) at low cost to measure the important parameters in the monitoring of passing trains. One of several possible applications is axle counting on railway tracks. The weight of the train exerts significant force upon the rail to generate a high strain/stress on the rail beam. A rail beam can actually be regarded as a simple structural beam experiencing compression, neutral and extension stratum.



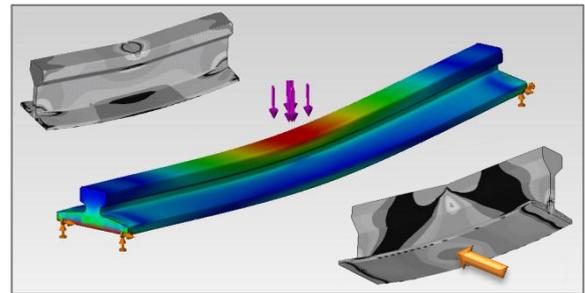
As each peak represents the presence of each axle, by counting the number of peaks generated from each sensor, the FBG can perform the function of axle counter.



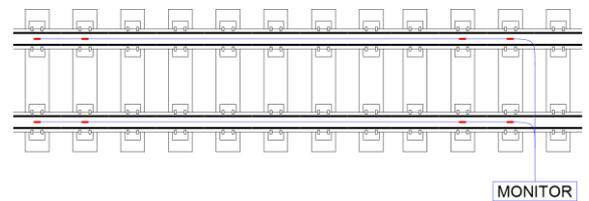
## SPEED AND WEIGHT ANALYSIS

With reference to the possibility to count passing axles, the same approach can be used to detect the speed of a passing train. Since the distances between the wheels are known, train speed can be easily computed by using just one FBG sensor. FBG sensors on rail tracks could thus be used as axle counters and at the same time provide important information for speed and weight measurements.

In a typical implementation multiple FBG sensors are installed on each side of the rail. This allows for instance detection of imbalances on the two sides of rail wheels. It is well known that if there are large difference between the left and right hand side loading of an axle, there is the danger of train derailment. Thus, it is generally required for freight trains to go through a Wheel Weighing System (WWS).



The images above illustrate the simulated stress modal of a load applied on a rail track. It appears that the spot pointed at seems a suitable place for an FBG sensor.



In essence multiple sensors placed along the track on both sides provide lots of train running information on axle counting, speed measurement and weight analysis.

## REFERENCES

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3. K. Y. Lee, K. K. Lee, S. L. Ho, "Exploration of Using FBG Sensor for Axle Counter in Railway Engineering", WSEAS Trans. on Sys., Issue 6, Volume 3, August 2004, pp. 2440-2447.