Summer: one of four difficult seasons for the railways

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Summer, spring, winter and autumn present serious challenges to Britain's railway: In autumn, storms blow juicy leaves on to the tracks, reducing the trains' ability to brake; in winter, trains can be blocked by snow and struggle to collect electricity; in spring, floods wash away embankments and tracks; in summer, the rails expand due to the heat from the air and the sun. Which of these phenomena creates the greatest risk for the users of the railway? It depends: train drivers are particularly concerned with their ability to brake, while track engineers worry about the risk of the track deforming, either just ahead of a train or during the passage of a train.

When heated, most materials expand. Steel rail lengthens by about 16mm per 1000m (about one inch per mile) when its temperature increases by 1°C. This may not sound much but railway track sections are seriously long and can be subject to substantial temperature changes, rapid increases of 5° to 10°C being quite common in summer. If, for example, the temperature of one kilometre of unconstrained rail rises from 27° to 35°C, it will grow by 128mm or five inches. Indeed, much greater increases occur because rail is very good at absorbing heat and, thus, it reaches temperatures that are well above those of the surrounding air.

Until about 40 years ago, most railway tracks were made up of 18m lengths of rail, held together with fishplates, where small gaps took up the expansion during hot weather. By contrast, modern railway track is constructed from 300m long 'strings' of rails, which are assembled into continuously welded rails (CWR) that have no gaps for many thousands of metres. Installed when the ambient temperature is cooler than 27°C, they are stretched with hydraulic equipment to the length that corresponds to that of the unconstrained rail at 27°C, the so-called stress-free temperature. Once welded, the rails are no longer free to move and compressive stresses are established as soon as the rails become warmer than 27°C. The resulting forces can lead to lateral movement of the rail, that is, the phenomenon of buckling. This is associated with risk of derailment. This must be managed by speed restrictions and line closures.

The last few years have produced many extreme weather events that affected Britain's railway infrastructure. These included the wet summers of 2007, 2008 and 2012, each of which resulted in widespread flooding and earthwork failure, and the windstorm Kyrill of January 2007, which caused severe damage to overhead lines. More recently, the severe snow and cold weather events during the first three months of 2013 resulted in stranded trains and journeys being delayed or abandoned.

The recent heat wave is the first widespread and prolonged period of high temperatures since 2006. Both the 2006 episode and the extreme heat wave of 2003, when 38.5°C became Britain's highest recorded temperature ever, disrupted Britain's rail network through buckled rails and the related speed restrictions. Although this year's temperatures are slightly lower than those of the previous episodes, the impact on rail operations has been significant, as witnessed by the thousands of passengers stranded at London Waterloo during the evening rush hour on 15 July 2013, because a rail buckled in a junction area. Part of the problem is that track defects develop unobserved during cooler years and emerge quite suddenly when a heat wave occurs. Then, lessons and skills have to be learnt afresh!

The University of Birmingham is a world leader in the assessment of the impact of climate change on transport and has been involved in several collaborative research projects with other institutions and stakeholders, such as Network Rail and the Highways Agency. Birmingham led the £1.4 million EPSRC-funded **FUTURENET project (http://www.arcc-futurenet.org.uk/)** which modelled the potential impact of the changing climate on road and rail transport between London and Glasgow, using the cutting-edge UKCP09 climate change projections. Through this and other groundbreaking and multidisciplinary research the University contributes to a future transport system that will remain operational whatever the weather.

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Birmingham Centre for Railway Research and Education (http://www.birmingham.ac.uk/research/activity/railway/index.aspx)