RAIL-TRACTION

ADVANCED
ADHESION IMPROVER

bsi. ISO 9001 Quality Management | ISO 14001 Environmental Management | ISO 45001 Occupational Health and Safety Management

part of
HOBEN INTERNATIONAL LTD

www.rail-traction.com

SAND IS FOR BEACHES

RAIL-TRACTION™ IS FOR RAIL

bsi. ISO 45001 Occupational Health and Safety Management

"Wet rail" is what happens when low levels of moisture are present at the train wheel/rail interface and can cause poor adhesion. These conditions are associated with very light rain or mist, and the transition between dry and wet rails at the onset of rain.

Wet rail conditions are the likely cause of around 60% of station overruns and other performance problems.

There are a number of ways to measure the impact of low adhesion but train delays for paying customers is perhaps the greatest.

RAIL-TRACTION

HIGH PERFORMANCE
ADHESION IMPROVER

HOBEN INTERNATIONAL LTD

INTRODUCTION

Rail-Traction was developed by Rodney Donmall and Craig Burgin of BCH Solutions over a 6 year period. During this time extensive R&D work was carried out in conjunction with Network Rail (NWR) and South West Trains (SWT) to perfect the product to ensure it provided enhanced adhesion performance verses traditional traction sands and overcame common usage problems of traditional traction such as blockages within the sanding systems due to elevated moisture levels.

In 2019 Hoben International, a subsidiary company of Goodwin PLC, obtained a global technology licence (Patent pending) from CRAROD Ltd (formerly BCH Solutions) and is now with the assistance of the inventors Rodney Donmall and Craig Burgin, working with the rail industry to supply Rail-Traction in place of traditional traction sand in order to combat Wet Rail Phenomena to help provide a safer and more efficient rail network.

The definition of 'Wet Rail Phenomenon'

Poor adhesion conditions are caused when low levels of moisture are present at the wheel / rail interface. These conditions are associated with dew on the rail-head, very light rain, misty conditions, and the transition between dry and wet rails at the onset of rain. They are not necessarily associated with the additional presence of other (non-water) railhead contaminants. These conditions are not associated with continuous rain.

Rail-Traction Adhesion Improver

The most effective way to mitigate 'Wet Rail Phenomenon' is the use of properly functioning, on-board sanders. Traditionally traction sand, a composite material of sand and aluminum, is commonly used in on-board sanding systems, Rail-Traction is a specially formulated Rail Adhesion Aggregate that that has been proven by independent testing, in conjunction with Network Rail and SWR, to be upto 28% more effective in adhesion improvement compared to traditional traction sand. Rail-Traction has been tested both online and offline and can be utilised with existing sanding systems as a direct replacement for traditional traction sand and meets the specified flow requirements at levels of moisture of upto 10%.

Why is Low Adhesion Such a Problem to a Modern Railway?

The railways have been operating with the same basic steel wheel on steel rail interface for over 200 years. This steel on steel interface was adopted not only because of its strength and low wear properties, but also because it offers a low rolling resistance thus reducing considerably the effort required to move heavy loads. However, this advantage sometimes becomes the railway's Achilles heel, particularly during the autumn

leaf fall season. During this time of the year, but not only at this time, the rail surface and the wheel treads can become coated with a range of contaminants. The worst of these are crushed leaves, which, when combined with moisture, particularly in the form of dew or condensation, reduces the adhesion level. For a train on dry rails adhesion is typically around 0.25, on wet rails it is around 0.15, but on damp leaf it can be as low as 0.015. Rails with damp leaves significantly constrain the rate of braking. Furthermore, it can also have a profound effect on train performance because low adhesion jeopardises acceleration as well.

Leaf related problems are not new and have been encountered for decades. Immediately after the demise of steam traction operation in the late 1960s, vegetation control was reduced allowing the lineside to sprout into 'linear forests'. As a result, the low adhesion problems got worse over time and it became necessary to re-instate high levels of lineside vegetation management. However, it is not always possible for the railway to manage all trees as they are not always on railway property.

Further, with the advancement of technology and changing train operation, more demand has been placed on higher adhesion levels to support higher braking rates, shorter yet faster trains and more frequent services. The nature of the difficulty encountered depends on a vast range of factors which change constantly. The 'adhesion profile' along any stretch of line varies within metres: the temperature and humidity levels can change rapidly; contaminants react differently to the passage of a train; the trains are driven differently; the trains themselves are different, and so on.

Low adhesion occurs all year round, not just in the autumn. Wet rails, accompanied by rail-borne contaminants, can offer low adhesion levels despite the rails looking clean. Analyses have shown as many station overrun incidents due to poor rail conditions can occur outside of the autumn period as during it.

The result of low adhesion is a number of problems:

- Reduced ability to stop trains, potentially leading to signal passed at danger (SPADs), station platform overruns and collisions.
- Reduced ability to start trains, accelerate and maintain speed leading to lengthened journey times.
- Damage to train wheels requiring trains, out of service for wheel re-profiling.
- Damage to rails requiring regrinding and premature replacement.
- Failure to activate track electrical circuits leading to potentially severe consequences.

What is the safety risk?

The main safety risk from low adhesion arises from incidents and accidents due to trains sliding through stations, open level crossings, passing signals at danger and collisions with other trains or buffer stops. In 2011, RSSB estimated this risk to be between 0.23 and 0.41 Fatalities and Weighted Injuries (FWI) per year.

Whilst this risk appears relatively small, the consequences of a low adhesion SPAD for example, could be catastrophic and hence continued management of low adhesion is essential.

What does it cost?

The annual cost of low adhesion to the GB rail industry as a whole has been estimated to exceed £100 million. This arises from many different causes, some of which are difficult to quantify:

- SPADs and station overruns
- performance delay minutes, cancellations and the resulting compensation payments
- reduced capacity from special leaf fall timetables
- line side vegetation management and leaf fence maintenance
- rail head treatment, train maintenance and operation
- repairing rail burns and broken rails
- wheelset re-profiling or renewal, including transport / transfer / crew costs/ reduced availability of rail stock
- sander maintenance and replenishment with sand
- installing / maintaining train detection equipment
- rapid response teams
- staff training and briefing, media and public relations
- incident investigation and response
- the cost of staff or customer confidence and bad publicity

This of course does not include the significant consequences of a serious incident such as a collision or derailment, which could occur as a result of increased braking distances or a failure of a track circuit to detect the presence of a train in a section.

Low Adhesion Explained

Adhesion on the railway, put in simple terms, is a measure of the Traction, or slipperiness, between the wheel and rail. We can measure adhesion levels and a value of adhesion is assigned normally expressed as 'μ ' (a decimal fraction) or sometimes as a percentage.

This μ value is approximately equivalent to the maximum possible rate of deceleration of a given train, when expressed as the percentage of deceleration due to gravity (g). This approximate relationship makes understanding the effects of adhesion on train braking much easier. For example, a modern disc-braked train has a nominal braking rate of about 9%g with a Full-Service brake application. Therefore, when all axles are braking their own weight, we need an adhesion level of at least 0.09 (9%) to support this braking rate without suffering wheel slide during braking. Note that, for simplicity, in the remainder of this manual we shall refer to the adhesion level as a percentage.

For traction purposes however, the adhesion level needs to be higher to start a train without the wheels spinning, ranging from 0.15 (15%) for a typical 4 car multiple unit, up to about 0.25 (25%) for a locomotive hauling a heavy freight train. This depends on a number of factors such as the number of motored axles, the axle loads and the trailing load, etc.

In dry weather with clean (shiny) uncontaminated rails, the adhesion level would commonly be found to be between 20% and 40%, in really wet conditions it may be between 10% and 20%. In both of these circumstances braking problems should not normally be encountered. However, adhesion levels lower than that required for Full Service braking are encountered from time to time, particularly in the autumn when moist crushed leaves on the rails can reduce levels to as low as 1%. For those familiar with the 3-Step brake system, this latter value is less than that required to sustain Step-1 braking! However, low adhesion can occur at any time of the year when moisture is present combined with contaminants.

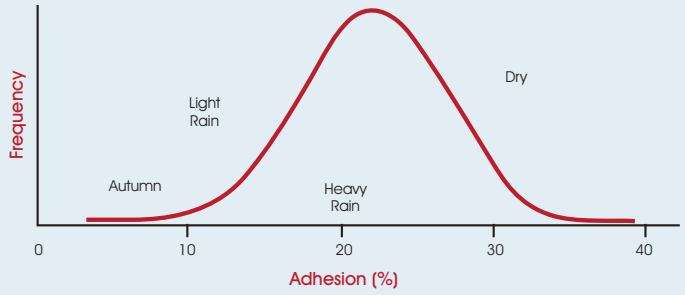
It should be noted that the spacing between signals is based on Full Service train braking (with an appropriate safety margin added), but braking instructions encourage Drivers to use lower braking rates, applying the brake earlier and possibly lighter at all times and especially when low adhesion is likely or is known to be present. It is convenient to classify low adhesion into a number of distinct bands as shown in the table below:

Adhesion Level	Typically	Description	
High	>15%	Clean rails wet or dry	
Medium	10-15%	Damp rails with some contamination	
Low	5-9%	Typical autumn mornings due to dew / dampness often combined with light overnight rust	
Exceptionally low	<5%	Severe rail contamination often due to leaves but sometimes other pollution	

It can be seen that modern trains demanding higher rates of deceleration will exceed the available adhesion under certain conditions. This is not too much of a problem for 'typical' autumn mornings as adjustment to the normal driving technique, driving slower and braking earlier / lighter, should compensate for the reduced adhesion by demanding a lower braking rate. These conditions can be compared to driving a road car on a wet road where braking distances will be extended as the tyres cannot Traction as well as they can on a dry road.

On the rare occasions when the rails are severely contaminated, such as with dampened leaf contamination, the adhesion level can be extremely low (levels as low as 1% have been recorded) and other measures are necessary to compensate for this such as the application of sand. These conditions can be compared to driving a road car on ice when not only do you need to drive slower but the Council needs to grit the road.

The graph below, produced from actual surveys undertaken in the 1990s by the British Rail Tribometer train, shows how frequently the various adhesion levels occur on the railway. It can be seen that the exceptionally low levels of adhesion (below 5%) are rare as are the very high levels (above 35%). For most of the time the available adhesion levels are well within those required to sustain normal braking and traction power demands.



Low adhesion is infrequent - autumn mornings
Very low adhesion is very infrequent - mostly damp leaf

Where does it come from?

Low adhesion arises from a number of causes, most notably from leaf contamination arising from lineside vegetation. Vegetation on the lineside has spread since the demise of track gangs employed to control it during the days of steam locomotive operation. However, it isn't all the fault of leaves on the line, a number of buffer stops collisions have occurred in the past due to rail contamination caused by station well cleaning scattering oil droplets onto the railhead; and damp, light rust following periods of non-use of the track has led to similar incidents.

The following list is by no means exhaustive but identifies some of the more typical causes of low adhesion.

- crushed leaves rolled on the rails by passing trains activated by moisture;
- general moisture / dampness (dew, condensation, ice etc.) mixed with contaminants on the rail such as rail wear debris or rust;
- the onset of light rain / drizzle after a dry period;
- dusts, particularly coal dust;
- airborne diesel fuel and lubricating oil droplets from diesel trains;
- airborne kerosene near airports and chemicals near industrial sites;
- leaking hydraulic fluid from track machines;
- defective rail mounted flange lubricators.

It can be seen that the causes can be split roughly into those that the railway has little or no direct control over (naturally occurring conditions such as leaves, moisture, rust, ice etc.) and those that are directly under our control ('man made' conditions such as fuel / oil spillages, defective flange lubricators etc.). To an extent, we can also reduce any safety risks to staff and passengers from contamination caused by our neighbours by seeking their co-operation in applying control measures. The biggest single cause of low adhesion problems is as we all know, are the 'wrong type of leaves' crushed onto the railhead by the train's wheels (under a contact pressure of over 30 tonnes per square inch) to form a hard 'Teflon' type coating on the

rails. It is known that leaves are drawn into the wheel / rail interface by the aerodynamic effects of passing trains and crushed under the wheels. This hard coating can cause track circuit operating difficulties when it is dry (acting as an electrical insulator) and causes braking difficulties when damp (acting as a lubricator). With very wet conditions, the crushed leaves are softened and then the layer is broken up by the action of passing trains and washed off the rails by the rain. However, it has been shown through testing that the coating can reform after the passage of just a few trains, if the right drying weather conditions are present.

How is low adhesion 'activated'?

This is one of the least well known subject areas. Setting aside fuel, oil and grease spillages which are obvious lubricators, water (moisture) is the common denominator in low adhesion. Dry leaf contamination or dry rusty rails, will not lead to low adhesion conditions, but add a small amount of water then the contaminant becomes 'activated'. The precise amount of water required is not generally understood, but more water is generally a good thing as it helps to soften the hard leaf-film layer and will wash other contaminants off the railhead. Ice can lead to low adhesion, not because of its surface slipperiness as the wheel / rail contact pressure will melt the ice, but because the melted ice is water. Certain atmospheric conditions will result in dew or light rain which will energise these low adhesion conditions.

In 2014, RSSB investigated the effects of moisture on rail adhesion (T1042). This research collated existing knowledge of the effects of moisture on rail adhesion to synthesise an evidence-based definition of 'Wet Rail Phenomenon' and review how mitigations could be improved. An extensive literature search revealed 283 pieces of relevant written evidence, which was then reviewed, and a knowledge map was created. Performance data was also analysed using a variety of sources, including Britain's national autumn performance and weather data from 2010, 2011, and 2012.

Key findings were:

- when visible contamination is present on the railhead, it will dominate the adhesion characteristics between the wheel and the rail;
- the most effective way to mitigate against this is the use of properly functioning, on-board sanders, and the treatment of the track by water jetting in conjunction with the application of adhesion modifiers;
- the performance data suggests that colder average air temperatures can significantly influence adhesion performance, possibly due to autumn frosts accelerating greater levels of leaf fall;

Two main scenarios leading to low adhesion events have been suggested although other factors may also contribute:

- a combination of a leaf layer and railhead moisture, often from precipitation, or the environmental changes leading up to precipitation. These events may occur throughout the day, but especially during the afternoon;
- morning dew interacting with contaminants such as oxides or leaves. These account for the high incident rate during peak morning service. Affected mornings tend to be during colder weather. There is a possibility that low adhesion events may be most likely to occur during the drying out of the railhead.

PRODUCT OVERVIEW

The Rail-Traction wet rail improver formulation has been developed and tested over a number of years in conjunction with South West Trains and the Network Rail Alliance Team who were tasked in finding a solution to mitigate the effect of low adhesion on the railway network.

The Alliance Performance Improvement Team anaylised past incidents which showed that the likely cause of 60 percent of station overruns and other performance issues were related to wet rail conditions. The majority of these over runs were by less than half a coach length or less than 10 meters.

Existing wet rail mitigations such as high pressure jetting and traction sand are not totally effective at improving adhesion under these conditions.

The Rail-Traction product increases frictional forces by nature of the aggregate coming between the rail and the wheel however the key functional difference when compared to traction sand is that it has the unique property of a significant drying effect on the rail head at the rail contact point due to the hydroscopic nature of the Rail-Traction compound. The University of Sheffield conducted testing which proved that this drying effect results in the trailing wheel sets having a dry contact point at braking, which significantly reduces braking distances when the Rail-Traction product is used.

SAND IS FOR BEACHES

RAIL-TRACTION™ IS FOR RAIL

"Wet rail" is what happens when low levels of moisture are present at the train wheel/rail interface and can cause poor adhesion. These conditions are associated with very light rain or mist, and the transition between dry and wet rails at the onset of rain.

Wet rail conditions are the likely cause of around 60% of station overruns and other performance problems.

There are a number of ways to measure the impact of low adhesion but train delays for paying customers is perhaps the greatest.

ADVANCED
ADHESION IMPROVER

RAIL-TRACTION

bsi. ISO 45001 Occupational Health and Safety Management

- *Improves wheel/rail adhesion live tests show improvements of 8%.*
- *Reduces wheel wear and the associated high costs.*
- *Uses all existing sand boxes and delivery equipment avoiding any unnecessary installation costs. Lighter weight and lower abrasion extend equipment operating life.*
- *Product flow 2kg/minute constant at high water content whereas sand totally blocks equipment.*
- *Reduces corrosion by absorbing all rail moisture.*
- *Does not represent a threat to human health and safety or biodiversity.*
- *Product shelf life greater than 10 years.*
- *Same cost as sand.*

HOBEN INTERNATIONAL LTD

COMPANY OVERVIEW

Hoben International Ltd, a subsidiary of Goodwin PLC, is located between Ashbourne and Matlock in the heart of Derbyshire occupying a 40 acre site with easy access to the UK's motorway network making it an excellent distribution hub for our products.

The Parent company of Hoben International, Goodwin PLC, was founded in 1883 and has specialized in high quality engineered products ever since. Goodwin PLC is still majority owned by the Goodwin family and is a premium listed company on the London Stock Exchange, it employs over 1,200 employees across the group of 23 companies. For more information please see www.goodwin.co.uk

Hoben International Limited is a ISO9001, ISO45001 and ISO18001 accredited company and we put quality management, environmental responsibility and H&S at the forefront of what we do.

Hoben International a leading manufacturer of formulated aggregate based products supplying into the automotive, railway, industrial and fire protection industries.

We are able to process imported and domestic raw materials through our crushing and screening plants or through the continuous Alumina lined ball mills to precise and exacting standards for a wide range of applications. Real-time in-line monitoring, using state of the art in-line particle analysers continuously adjusts the classifiers to produce optimum product quality.

We have a range of blending plants to suit various product and customer requirements. Hoben has extensive experience in controlling and blending materials with a particle size with demanding and highly technical specifications.

Contract processing of more specialised raw materials, often having difficult and unusual characteristics and often requiring dedicated plant, is an increasing requirement is not an uncommon activity on our site. We offer a complete service to meet specific customer needs from our wealth of experience in processing minerals.

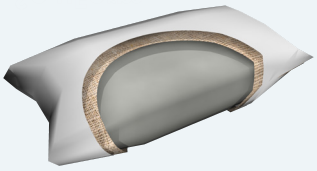
Hoben International puts quality and consistency first. Our highly trained and experienced Research and Development team are made up of PhD Chemists and Industry experts that have vast knowledge covering many industry sectors.

All raw materials and finished products are rigorously tested in line with our ISO9001 and quality management system and other specific customer requirements. Examples of analysis equipment that is used for R&D and product control are as follows:

- Scanning Electron Microscope (within UKAS accredited laboratory)
- X-Ray Florescence (XRF) elemental analysis
- X-Ray Diffraction analysis
- Differential Scanning Calorimetry (DSC)
- Ultrasonic and Thermal profiling
- Wet & Dry Laser Diffraction Particle Size analysis
- Thermal Expansion analysis
- Compressive and MOR Strength analysis
- Crushing Strength analysis

Whilst continuing to maintain our successful position in the highly competitive minerals processing sector, the company plays an increasingly active role in servicing industry needs of improved standards, quality and reliability, providing products that meet the needs of markets that have to satisfy ever increasing environmental demands.

SoluForm



Soluform

Soluform have developed and patented a range of biodegradable bags, for use inside traditional hessian/jute bags or on their own, for the placement of concrete in or around rivers. The use of liners or bags is needed to ensure that cement fines are confined to the bag and not able to leak out into the environment during the vulnerable stage in construction - whilst being placed and prior to the concrete hardening.

Non Ferrous Foundry Plaster

Hoben International are the worlds leading manufacturer of Foundry Plaster which is a gypsum bonded investment formulated for casting Non Ferrous Metals. Foundry Plaster is used in the Rubber Plaster Mould (RPM) process which utilises a reclaimable pattern of silicone rubber.

Hoben Foundry Plaster has been used for many years by leading foundries specialising in the high volume production of turbocharger compressor wheels. Foundry Plaster is also used for the manufacture of lower volume castings and in the rapid prototyping sector.

SANDERSFIRE INTERNATIONAL

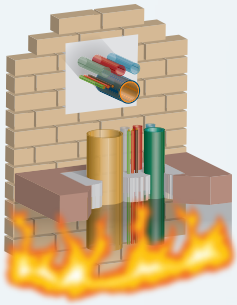
A Division of Hoben International Limited

Sandersfire

Passive fire protection products

Firecrete - fire stopping mortars with load-bearing capacity for sealing mechanical and electrical service penetrations through walls and floors;

Fireslab - a simple and cost effective means of upgrading the fire resistance of a timber floor (complies with Part B of the Building Regulations).



SILVAPERL SILVAPOR

Perlite

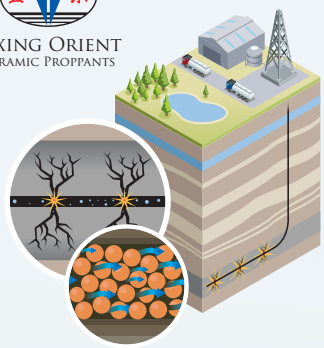
Expanded perlite is a white, ultra-lightweight aggregate ranging from a very fine powder to an aggregate with a particle size up to 6mm in size. It is inorganic, inert, neutral in pH, biologically stable and has no asbestos content. It has excellent thermal insulation properties over an extremely wide temperature range from cryogenics at minus 273°C (absolute zero) up to refractory applications at over 1000°C. It also has a highly adsorbent surface and a very low bulk density which makes it an ideal carrier or low cost filler for many compound formulations.

HOBEN INTERNATIONAL LTD

Ducamix

Ducamix is a blend of Cement, lightweight aggregates, including Perlite. The mixture forms a lightweight concrete for high temperature application e.g. for fireplace and hearth manufacturing and around boilers.

YIXING ORIENT
CERAMIC PROPPANTS



Ceramic Proppants

For Hydrocarbon Production

Hoben International is a mineral processing company with a long history of supplying a wide range of industries.

Hoben International count major production and supply companies amongst their customers and have been providing Silicas for the North Sea Drilling Program for the past 15 years.

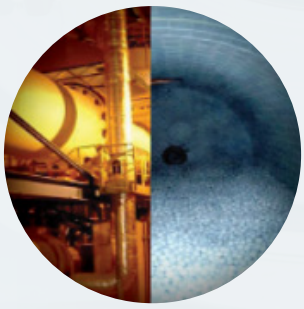
Hoben International has been chosen by Yixing Orient as exclusive distributors of their Ceramic Proppants for the UK, Denmark and the North Sea hydrocarbon production areas.

Cristobalite Sands and Milled Flours

Hoben manufacture high grade, unmineralised Cristobalite using a state of the art custom built calcining facility which was commissioned in 2006.

With a capacity of around 15,000 tonnes per annum, Hoben services our group companies with all their Cristobalite requirements. Calcining quality is controlled and maintained by the use of X-ray diffraction, enabling Hoben to supply consistent product to exact specifications.

Cristobalite can be supplied as sands or as milled flours produced through our in house ball milling facilities. We offer a range of Cristobalite products, please refer to the product data sheets for full details.



Silica Sands and Milled Flours

Hoben are specialists in processing hard minerals, such as Silica, into fine powders. Silica is milled in our continuous process ball mills. All our mills are fully automated, have Alumina linings and are charged with Alumina grinding media to ensure our materials are free from metal contamination.

Particle sizing is controlled by in-line particle size analysers that continually adjust an in-line classifier giving ultimate consistency within product specification.

Braking bad: improving wet rail performance

Article taken from Rail Professional March 2017

Published on Feb 21, 2017

Even though the cold weather has long been underway, many train operating companies will still have one eye firmly on performance from the autumn 2016 period

Seasonal specialists from the joint South West Trains/Network Rail Alliance Performance Team have been working on a project to improve autumn performance since late 2014, and think they may have found a solution in the form of a new 'wet rail improver' product.

The Alliance Performance Improvement Team was tasked with looking into how it could mitigate against the low adhesion effect of wet rail across the Wessex line of route. The team analysed past incidents which showed that the likely cause of around 60 per cent of station overruns and other performance issues were related to wet rail conditions. The majority of these overruns 'Wet rail' is what happens when low levels of moisture are present at the train wheel/ran interface and can cause poor adhesion.

> 'Wet rail' is what happens when low levels of moisture are present at the train wheel/rail interface and can cause poor adhesion. These conditions are associated with dew on the rail-head, very light rain or mist, and the transition between dry and wet rails at the onset of rain

These conditions are associated with dew on the rail-head, very light rain or mist, and the transition between dry and wet rails at the onset of rain caused by wet rail were by less than half a coach length, or less than ten metres.

According to Duncan Wilkins, fleet Director for South West Trains: 'The wet rail phenomenon is an industry-wide problem that has both safety and performance implications to the operational railway.

That's why coming up with a solution is crucial so we can deliver a more reliable service to our passengers, whatever the conditions.'

Existing wet rail mitigations such as high pressure water jetting and traction sand are not totally effective at improving adhesion under these conditions.

For this reason, our seasonal specialist contacted two third-party suppliers, external to the rail industry. to find out if there were any innovative solutions out there that had not been considered, BCH Solutions and Santander Salt, with expertise in adhesion and de-icing technology, were tasked with developing a product that would improve adhesion when rail conditions are wet and that could be deployed from existing ontrain sanding equipment. The reason for asking for the product to be part of on-train sanding equipment was that it could then be dispersed quickly and at short notice. As wet rail conditions are notoriously difficult to forecast, this was seen as the most practical solution.

After three months in development, a prototype product was produced by BCH Solutions and Santander Salt utilizing hydroscopic minerals that can absorb water almost instantaneously.

Testing was conducted at the University of Sheffield and showed that the product was effective at drying railheads within the rail contact point. This would result in trailing wheel sets having a dry railhead making braking more effective.

A practical testing plan was then created to further prove the concept before proceeding to full scale trials on the network.

The first phase of testing was conducted with the assistance of the Romney, Hythe & Dymchurch railway. A number of test runs were carried out to measure train braking on dry rails, wet rails, wet rails treated with traction sand and wet rails treated with the new product. Testing showed the new product reduced the required stopping distance by7.8 per cent compared to existing traction sand.

Lab to real world environment

The Performance Improvement Team was mindful that the Romney, Hythe & Dymchurch railway is a 15" narrow gauge which is on a smaller scale than the Wessex line of route. While testing on this scale is not fully representative of the standard gauge network, it proved that the effect that was observed in the labs could also be seen in a real world environment.

The second phase of testing was conducted at South West Trains' Wimbledon depot and tested the flow rate through class 456 sanding equipment. The product flowed through the equipment freely without causing damage or blockages.

The first and second phases of testing are now being independently validated and the third phase is being planned which involves controlled testing on the mainline network to replicate the results seen on the Romney, Hythe & Dymchurch railway.

Duncan Wilkins highlighted the collaborative nature of the project to alleviate the impact of wet rail conditions for passengers. He said: 'This project is a great example of how joint working between train operators, Network Rail and suppliers can deliver innovative solutions for the industry.

'By improving rail adhesion we can reduce instances of trains sliding which means our fleet can spend more time in service on the network and less time on the wheel lathe being repaired. That's why we're hopeful this new wet rail improver product continues to perform well in our testing and that we can use it operationally to make a difference in future.'