



## Proud sponsor of Seven Wonders of the Railway

SYSTRA is a global leader in public transport infrastructure. Our 6,200 employees specialise in engineering and consulting. In the UK, SYSTRA Ltd provides rail and urban transport engineering services and transport planning consultancy. We deliver for high speed, conventional rail, metro and light rail clients across the UK and Ireland.

Our own seven wonders include EGIP Electrification, Cambrian Lines ERTMS, Thameslink Signalling, Dublin Electrification, Crossrail Central Section, Ashford International Signalling, and HS1.



## Happy Birthday SYSTRA Ltd

SYSTRA Ltd celebrated its 50th anniversary on 2nd December 2018. The original UK company, Alan M Voorhees and Associates (AMV) was registered in the UK on this date in 1968. Our company has evolved from its beginnings on the Tyne and Wear Transport study, which resulted in the first Light Rail system in the UK, to being a tier one rail engineering supplier.

Our sincere thanks to all the people – colleagues, clients and partners – that have supported the company over the last 50 years. We look forward to working with you and many others in future to help develop sustainable, safe and efficient transport systems.

We will be celebrating our successes over the coming months, keep a look out on Twitter and LinkedIn #SYSTRA50.

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# Welcome to the Seven Wonders of the Railway

The railway has not had a good year in many ways. It's taken a beating in the national media and from passengers, sometimes for reasons that are hard to dispute. But hidden among the negative headlines are many great achievements of which UK rail can rightly be proud.

Each year, we recognise the best of those projects, teams and individuals who give the railway something truly worth shouting about at RAIL's National Rail Awards. This year however, we also wanted to give a nod to the incredible feats of engineering, spectacular ingenuity and innovation that have shaped the railway we have today - the ones that might be overlooked in most awards criteria because they have simply stood the test of time.

We decided to find out which of the UK's stations, bridges, viaducts, tunnels or routes really stand out from the crowd and what it is that makes them so very special. Whether it is their impressive architecture, unique qualities, or the challenges that were overcome to achieve the seemingly impossible, we left the

criteria entirely up to you.

Earlier in the year, we asked well-known individuals from across the industry, and RAIL readers alike, to nominate a contender and provide a short citation to support their choice. When the nominations were in, we published the full list and asked readers and the wider industry and public to vote for the final seven.

You voted in your hundreds and we were not disappointed with the results. The final choices show that there are fantastic contributions to the railway's history and its operation today - all across the country and in every aspect of its construction.

Today's railway has been shaped by every train, station, bridge, tunnel and person who has touched it. The Seven Wonders described in this special RAIL issue are those you felt deserved to finally be recognised for the part they have played in giving us this country's spectacular railway. ■

**Stefanie Foster**  
Assistant Editor, RailReview



SYSTRA is very proud to sponsor the Seven Wonders of the Railway - a celebration of outstanding rail engineering across Britain's railways, especially as these awards coincide with our 50th anniversary in the UK.

Since before the Victorian era, British engineers have been designing stations, bridges, viaducts, tunnels and routes across the country. And as you

read this, our team are busy doing just that, working hard on the design of what will surely be this country's next 'Wonder'.

The 42 nominations for these awards cover the length and breadth of the country and span centuries, from 1726 to the present



day. They capture the essence of everything that is great about our British railways.

At SYSTRA, our strong heritage of innovation, ingenuity and engineering excellence has stood the test of time and shapes the way we design new infrastructure today. We often face the challenge of improving existing buildings and structures while maintaining their character and history. It is fantastic to celebrate British rail engineering in this way, so we thank RAIL for promoting the idea and facilitating these prestigious awards.

SYSTRA has contributed to several of the nominated 'wonders', and hopes to contribute to many more award-winning projects in the future. ■

**Steve Higham**  
Managing Director – Engineering,  
SYSTRA

# The Seven Wonders of the Railway

**p58-59 Ribbleshead Viaduct**

**Nomination:** This 24-arch viaduct towers above the Yorkshire moorland on the Settle-Carlisle Line, but further away the landscape turns the tables and this stone edifice seems to get lost against the backdrops of Wharfedale, Ingleborough and Pen-y-ghent. But it must be one of the most photographed and easily recognisable features on Britain's railways. Ribbleshead Viaduct is 28 miles north-west of Skipton and 26 miles south-east of Kendal. The Grade 2-listed viaduct is the longest and third tallest structure on the 'S&C'.

Designed by John Sydney Crossley, who was chief engineer of the Midland Railway, the viaduct was necessitated by the challenging terrain of the route.

**p56-57 The Liverpool & Manchester Railway**

**Nomination:** The Liverpool & Manchester Railway is where it all came together. This was the world's first inter-city railway, and the first railway designed and built with a double-track main line. It was laid out for steam use over the vast majority of its length, and was built with passengers in mind as the major traffic from day one.

The station at Manchester Liverpool Road, now the Museum of Science & Industry, laid out principles of operation that we can still see in stations and airport terminals to this day. Structures such as the Sankey Viaduct were on a scale not seen since Roman times and were built to carry 21st century loads.

Post-Rainhill steam locomotives were almost all built on the principles of the LMR's famous *Rocket*, right through to *Evening Star*. I always date the start of the railway age to the opening of the LMR on September 15 1830.

Andy Savage, Executive Director, Railway Heritage Trust

**p54-55 Great Western Railway main line (London-Bristol)**

**Nomination:** HS2, TGV, the Japanese Shinkansen - all owe their origins to the Great Western Railway. The GWR's directors wanted a railway that linked London and Bristol. But engineer Isambard Kingdom Brunel felt that was a limited view - he saw an opportunity to get people from London to New York as quickly as possible.

The GWR main line is what genius looks like: a ruling grade of 1-in-1,320, innovative engineering solutions and a track gauge purpose-built for speed. What makes it a true wonder is that Brunel was able to take this futuristic taste of rail travel and blend it seamlessly into the landscape.

Revolutionary ships; railway villages for workers; the production line arrangement of Swindon Works; quality refreshments; the Great Western main line is much more than just a railway, and yet the first part opened just 13 years after the Stockton & Darlington. Its influence can still be felt today.

**p62-63 West Highland Railway Extension (Fort William-Mallaig)**

**Nomination:** There aren't enough words in the English language to fully describe a journey from Fort William to Mallaig. It truly is an icon of scenic beauty, from its route past the deepest loch in Scotland (Loch Morar), through the most westerly station in the UK (Arisaig) and the foothills of Ben Nevis. This is a sublime part of the world.

But what makes the Mallaig Extension special is how the railway builders tamed this wild landscape with mass concrete, the most enduring memorial to this new technology being Glenfinnan Viaduct, another railway structure that deserves the term 'iconic'.

It's amazing that thanks to a fictional student wizard in a blue Ford Anglia, the Mallaig Extension is now one of the most famous railways in the world and has made it much more of a success as a tourist attraction than as a way to get fish to market. Couple that with the only railway on the national network where steam trains pass on an almost daily basis, and the Mallaig Extension really earns its place as one of the world's great railway journeys.

**p52-53 The Forth Bridge**

**Nomination:** Here is a structure that needs no introduction. That giant vision of red girders spanning the Firth of Forth really does deserve the title 'iconic'. It's vast, yet elegant, and fully deserves its UNESCO World Heritage Site status.

The bridge combined the engineering genius of Sir John Fowler (Metropolitan Railway), William Barlow (St Pancras roof) and Sir Benjamin Baker (Aswan Low Dam). It may look over-engineered but it was designed in response to the collapse of the Tay Bridge - and, 130 years after it was built, it's now carrying nearly 200 trains a day.

Any structure that becomes a simile - "as long as painting the Forth Bridge..." - surely deserves to be a wonder of the railway.

**p60-61 St Pancras International Station**

**Nomination:** It has to be St Pancras International! If I look that good when I'm 150, I will be delighted. I love St Pancras because it has a unique history. It provides a great experience for rail users and visitors and has shown that the past and new worlds can rub along together quite nicely.

From that wonderful Barlow roof to the history based in beer, the pianos, the art and the employees who work there daily, St Pancras really has something for everyone.

Finally, there aren't many railway buildings that feature on Trip Advisor. But St Pancras does, and this just goes to show the huge amount of interest and passion that it generates.

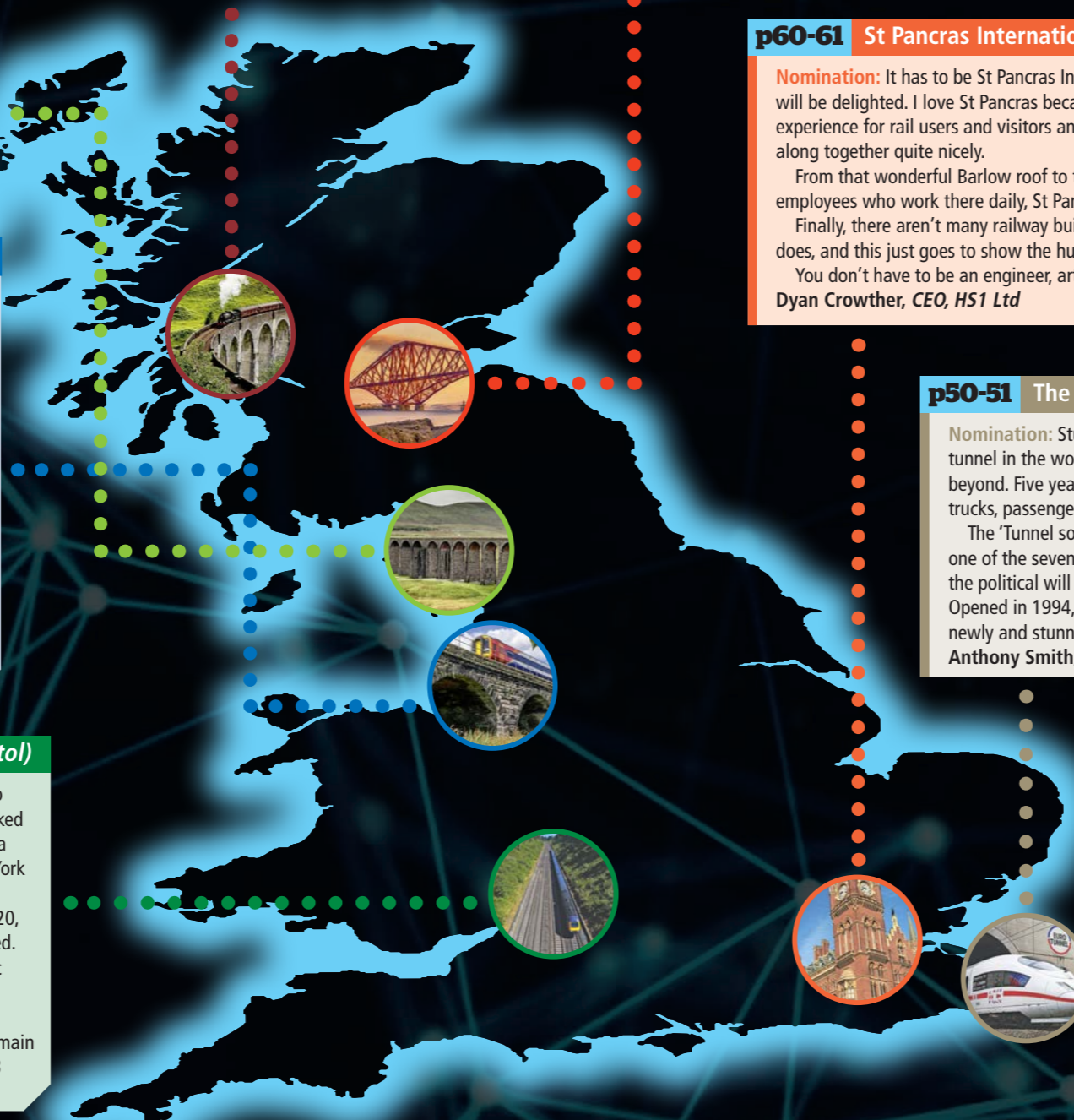
You don't have to be an engineer, artist or train-spotter - St Pancras caters for everyone. Dyan Crowther, CEO, HS1 Ltd

**p50-51 The Channel Tunnel**

**Nomination:** Stupendous facts: over 25 miles long, the longest undersea tunnel in the world carries 30% of the UK's trade with the Continent and beyond. Five years in the making, and now carries thousands of cars, trucks, passengers and containers between Britain and France.

The 'Tunnel sous la Manche', as the French call it, is widely regarded as one of the seven wonders of the modern world. No less remarkable was the political will to build this tunnel between Britain and the continent. Opened in 1994, it was made complete by the High Speed Link to the newly and stunningly restored St Pancras.

Anthony Smith, Chief Executive, Transport Focus



**The Contenders**

An impressive 42 potential 'wonders' were nominated. You can read the supporting citations that were provided for each on the RAIL website ([www.railmagazine.com](http://www.railmagazine.com)) but here is the complete list of nominations:

- Barmouth Bridge
- Blea Moor Tunnel
- Box Tunnel
- Cambrian Line (*Machynlleth-Pwllheli*)
- Causey Arch
- Channel Tunnel
- Claydon Tunnel
- Conwy & Britannia Bridges
- Dawlish Coast Line
- Digswell Viaduct
- Ffestiniog Railway
- Forth Bridge
- George Stephenson's birthplace
- Glenfinnan Viaduct
- Goathland station
- Great Western Railway main line (*London-Bristol*)
- High Speed 1
- Horseshoe curves, Tyndrum
- Kings Mill Viaduct
- Liverpool & Manchester Railway
- London King's Cross station
- London Paddington station
- Maidenhead Bridge
- Meldon Viaduct
- Metropolitan Railway (*the original London Underground*)
- Northenden Junction signal box
- Ordsall Chord
- Railway People
- Ribbleshead Viaduct
- Royal Albert Bridge
- Royal Border Bridge
- Settle-Carlisle Line
- Severn Tunnel
- Snowdon Mountain Railway
- St Pancras International station
- Stockport Viaduct
- Thames Tunnel
- Totley Tunnel
- Tottenham Court Road station
- Victoria Bridge
- West Coast Main Line
- West Highland Railway Extension (*Fort William-Mallaig*)

**What happens now?**  
Each of the winning seven will receive a special plaque either for display on the structure, if appropriate, or in the offices of the company responsible for its ongoing care. RAIL will feature each of the seven in more detail in future issues.

# The Channel Tunnel

**Built in a more optimistic era of bonhomie with our European neighbours, the Channel Tunnel is an engineering masterpiece**

Already considered to be one of the Seven Wonders of the Modern World, the Channel Tunnel has also now been voted as one of RAIL's Seven Wonders of the Railway.

The ambitious idea to tunnel under the English Channel began as long ago as 1802, with a proposal to Napoleon by mining engineer Albert Mathieu-Favier for a tunnel lit by oil lamps and traversed by horse-drawn stagecoaches. Fast forward 185 years and, in 1987, construction finally began, albeit for a tunnel to carry trains, rather than horses.

The project was beset by a number of false starts, but on May 6 1994, the longest undersea tunnel in the world finally opened. At 31.4 miles (50.5km) long - of which 23.5 miles (37.9km) is under the Channel, it is a common misconception that the Seikan Tunnel in Japan holds the record for being the longest. While Seikan is 33.5 miles

(53.9km) long (two miles longer than the Channel Tunnel), only 14.5 miles (23.3km) are under the seabed.

At its lowest point, the Channel Tunnel is 75 metres under the seabed. It is one of the biggest feats of engineering the UK has ever undertaken, with more than 13,000 English and French workers taking more than five years to build it.

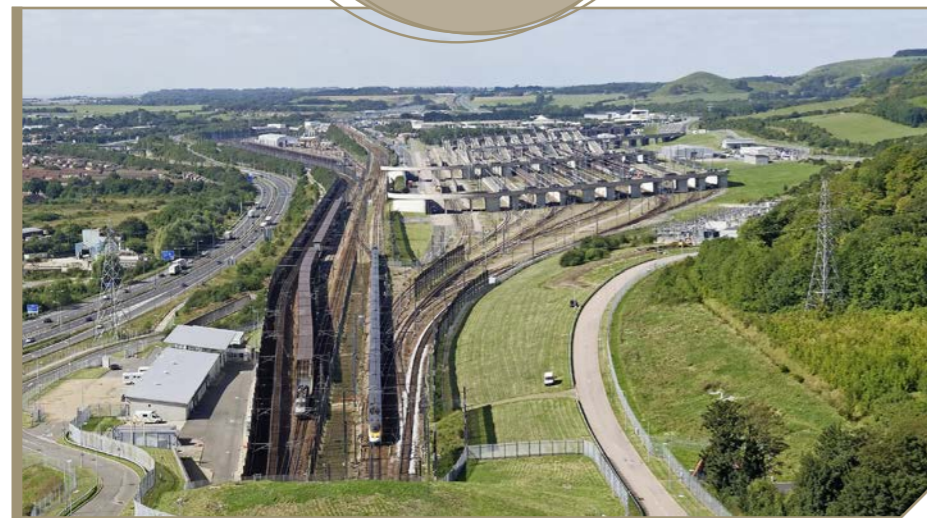
Construction began from both sides in 1988 with an impressive 11 tunnel boring machines working on the project, weighing a combined total of 12,000 tonnes (that's 1,000t more than the Eiffel Tower). They excavated the thick chalk

marl to bore two operational tunnels, with a third service tunnel in between. One operational tunnel runs towards France, the other to the UK, with connections to the service tunnel provided at regular 375-metre intervals by cross-passages.

The service tunnel allows for maintenance and

### Did you know?

If you put all the vehicles that have been through the Tunnel bumper to bumper, the line would be almost long enough to reach the moon and back from Earth (more than 477,700 miles).



The 1040 Waterloo-Paris Eurostar is about to enter the Channel Tunnel at Cheriton on September 11 2007, as a lorry shuttle leaves the tunnel in the opposite direction. BRIAN STEPHENSON.



A Deutsche Bahn ICE3 train at the entrance to the Channel Tunnel at Coquelles (France) on October 13 2010. DB took its first step towards running a passenger service between the UK and Germany through the Tunnel, with a test under its own power. PA PHOTOS.

recovery by emergency services and evacuation when necessary. Ingeniously, the air pressure inside this service tunnel is higher than the operational tunnels to prevent smoke filling it in the event of a fire in the rail tunnels (an incident which has unfortunately occurred more than once over the years).

Formally opened by Her Majesty The Queen and French President Mitterand in 1994, full provision of services was still some way off. It was not until 2007 that the first Eurostar service ran under its own power through the Tunnel, with the first Paris to St Pancras train running in September of that year, and High Speed 1 opening two months later.

There are several ways of crossing the Channel Tunnel: on the Eurotunnel Le Shuttle roll-on roll-off service for road vehicles (including drivers and passengers); on Eurostar

passenger trains; and freight trains. The Tunnel has sadly never achieved the volumes of passenger and freight traffic that were estimated before construction, although the figures have improved since High Speed 1 was opened in two stages in 2003 and 2007. As it stands, 20 million passengers, 2.6 million cars and 1.6 million trucks use the Tunnel every year.

Open access operation was approved through the Tunnel in 2010, allowing Deutsche Bahn the opportunity to run a German Intercity Express (ICE) train through the Tunnel as a test.

Since its opening, the equivalent of six times the population of the UK has made the crossing (around 390 million people). And since the Millennium, more than two million dogs and cats have crossed through.

More than one million express delivery parcels are sent through it every single day, and

a staggering 80 million vehicles have boarded the Shuttle since it opened. In fact, 25% of UK trade with continental Europe passes through the Tunnel.

This, of course, means that Brexit presents many challenges for Eurotunnel, which has been preparing for the UK's departure from the EU ever since the referendum. As with everything else, the full effects of Brexit on its services are yet to be understood...

### Key Facts

**Length:** 31.4 miles (50.5km)  
**Depth:** 75 metres below seabed  
**Construction time:** Five years  
**Owner:** Eurotunnel  
**Cost to build:** £4.65 billion

The Channel Tunnel has suffered its fair share of controversy over the years - not least being the location for the infamous "wrong kind of snow" stories in 2009, in which five London-bound Eurostars failed inside the Tunnel, trapping 2,000 passengers for around 16 hours during the coldest temperatures in eight years. The incident was caused by electrical failures caused by the lighter, fluffier snow. Sadly, this is a phrase that still pops up to mock the railway in times of trouble.

Despite taking nearly two centuries to move from idea to reality, and overcoming many significant setbacks over its construction and operation, the Channel Tunnel is one of the most impressive feats of engineering in the world. It is undoubtedly a Wonder of the UK's railway as well as a deservedly being a Wonder of the Modern World. ■

# The Forth Bridge

It would have been a great surprise if the iconic Forth Bridge had not made it into the Seven Wonders of the Railway. Voted as Scotland's greatest man-made wonder in 2016 and designated a UNESCO World Heritage Site, it is a marvel of Victorian engineering like no other.

Opened in 1890, the Forth Bridge is now a quarter of the way into its second century in existence, and carries traffic far heavier than its designers and builders had ever imagined. Spanning the Firth of Forth, from Fife on the north bank to Edinburgh and Lothians on the south, the bridge was designed by English engineers Sir John Fowler and Sir Benjamin Baker as a winning entry in a competition to find an alternative solution to the ferry link that existed at the time.

There had been tunnel proposals in 1805 that came to nothing, and a suspension bridge proposal by Sir Thomas Bouch in 1871 (but he was discredited after the collapse of the Tay Bridge in 1879, so this also never came to pass).

Work began on the epic construction project in 1882 and, for the next eight years, a total of 4,600 men worked on the build. There are

**The Forth Bridge viewed from South Queensferry in the low winter morning sun on December 29 2016.**  
DOUGIE MILNE/ALAMY.

## A symbol of innovation, strength and Victorian vision, the Forth Bridge is a rugged piece of engineering built to endure in a harsh environment

conflicting reports as to how many of those men lost their lives during construction, but the figure is close to 100. It had been estimated that it would take 42,000 tonnes of steel to construct, but in reality the figure was closer to 53,000. A staggering 6.5 million rivets were all heated on-site in oil-fired furnaces and hammered into place.

The figures involved in the bridge's construction are eye-watering. The final structure is 2,467 metres in length, which is just over 1.5 miles. At its highest point, the bridge stands 110 metres above the water and 137 metres above its foundations. The piers were constructed from 120,000 cubic yards of concrete and masonry, which are faced with 2ft-thick granite.

It is a giant in every sense. Each of the main spans consists of two 680ft arms, which support a central

350ft span truss. The two main cantilever spans are 1,700ft, plus two side spans of 680ft and 15 approach spans of 168ft. Upon completion, this made it the longest single cantilever bridge span in the world (now it takes second place behind the Quebec Bridge in Canada).

The Forth Bridge was also a pioneer for other reasons - it was the first major structure in Britain to be built of a then-untried and untested material - steel - rather than the more common wrought iron.

With all that steel, painting the Forth Bridge is a serious feat in itself. In 2001, Network Rail began a task which is often portrayed as never-ending, with the assistance of principal contractor Balfour Beatty. The bridge had been suffering from over a century of beating by the harsh Scottish weather, and exposed old paint layers were flaking off the steel.

**Did you know?**  
The last rivet of the Forth Bridge was driven by the Prince of Wales (later to become King Edward VII) in a howling wet gale on March 4 1890.



**A southerly view from the top of the Fife cantilever, with Inchgarvie island lying just to the east of the bridge. RAIL's Nigel Harris took a once-in-a-lifetime trip onto the Forth Bridge in December 2011 shortly after the decade-long repainting job was completed. You can read the fascinating story of his experience in RAIL 686. NIGEL HARRIS.**



**Looking down from the under-track catwalk, a pair of abseilers are dwarfed by the massive 12ft diameter riveted steel tubes. NIGEL HARRIS.**

On December 9 2011, the sometimes 400-strong team finished a decade-long repainting job that had involved shot-blasting and painting the bridge's 230,000m<sup>2</sup> of steel with 240,000 litres of paint.

It's also not just any old paint. The coating on the Forth Bridge is one of the world's best technical paints, developed and manufactured by Leighs of Bolton. The colour is officially known as 'Transgard TG168', but it's far more commonly known as 'Forth Bridge Red'. It is only ever used on the Forth Bridge and nowhere else. This high-quality paint is expected to last for 20 years, which is a good job considering it takes half that

time to paint the whole structure.

This was the first time in its history that the structure had been entirely repainted.

There are now 1,040 lights installed throughout the bridge, that use around 35,000 to 40,000 metres of cable. All those lights are necessary when you consider that 200 trains now use the bridge every day, carrying approximately three million passengers every year. After all, it was the Forth Bridge that created an unbroken East Coast Main Line from London all the way to Aberdeen.

These words from the successful nomination to register the Forth Bridge as a World Heritage

Site encapsulate exactly why this icon deserves to be recognised as one of RAIL's Seven Wonders of the Railway:

"The Forth Bridge is a globally important triumph of engineering, at once structural and aesthetic... It represents the pinnacle of 19th-century bridge construction and is, without doubt, the world's greatest cantilever trussed bridge..."

"No other trussed bridge approaches its perfect balance of structural elegance and strength, nor its overall scale, and no bridge is so distinctive from others as is the Forth Bridge from its peers." ■



**Key Facts**

- Length:** 2,467 metres (just over 1.5 miles)
- Height above water:** 110 metres
- Steel used:** 53,000 tonnes
- Rivets:** 6.5 million
- Owner:** Network Rail
- Cost to build:** £1.6 million

# The Great Western Railway (London-Bristol)

**T**he Channel Tunnel Rail Link, France's TGV, Japan's Shinkansen - all these high-speed railway lines owe their origins to the Great Western Railway.

The GWR's directors wanted a railway that linked Bristol with London. What they got was the world's first purpose-built high-speed railway, thanks to the extraordinary vision of Isambard Kingdom Brunel.

Brunel didn't just see a railway between Britain's capital and what was regarded then as its second city. He saw it as an opportunity to

## Taking an unconventional approach to a unique project, Isambard Kingdom Brunel's vision encompassed much more than just the railway

get people from London to New York as quickly as possible. But how did you create a high-speed route in the 1830s?

First there was the route. Brunel ignored previous surveys and went for the Thames Valley, where the broad, flat plains were ideal for the construction of a railway. The trade-off

was then having to cross the rather more hilly landscape between Swindon and Bath.

Plans to tunnel under Box Hill on a 1-in-100 gradient were met with howls of derision from some scientific quarters. Dr Dionysius Lardner emerged as one of Brunel's biggest critics, claiming that a runaway train would accelerate to 120mph, killing everyone on board.

Building through the Thames Valley required incredible feats of engineering. Many believed that the 'sounding arch' bridge at Maidenhead would never be able to stand up, let alone carry the weight of a train. But Brunel had calculated that he could cross the River Thames with just two arches, thus keeping it open for navigable traffic and without interrupting his 1-in-1,320 ruling grade. It worked so well that the GWR literally copied Brunel's original design when the line was quadrupled.

A hill near Sonning, on the approach to Reading, presented another headache. Brunel's solution was to dig through it with an enormous cutting.

The Great Western Railway Company's Bill finally received Royal Assent on August 31 1835. It had taken three years since a group of Bristol dignitaries had got together with a view to building a railway to London.

But the legal wranglings weren't over yet. There was one clause missing from the Bill and it was a deliberate omission. High speed wasn't just restricted to a level route. Increasing the track gauge to 7ft ¾in brought a stability not possible on the 4ft 8 ½in gauge that had been adopted by the Stockton & Darlington, the Liverpool & Manchester and the companies that would build the West Coast Main Line. It had become the de facto standard gauge.

But Brunel knew that making the track gauge wider would enable greater stability at higher speed. There was another by-product - you could get more people and goods into a wider train.

Brunel had had the idea of a wider gauge

in the back of his mind ever since he first surveyed the route, but he didn't tell the company directors. He'd successfully persuaded Lord Shaftesbury, Chairman of Committees in the House of Lords, to allow the clause about gauges to be removed. But he didn't fully explain himself to the GWR's directors until September 15 1835!

Luckily for Brunel, the directors had decided not to share Euston station with the London & Birmingham Railway, and that the railway would build its own terminus.

They gave Brunel their backing for broad gauge on October 29. It was a decision that they'd regret, as Brunel's own design of track - the bridge rail he penned mounted on longitudinal timbers - created an appalling ride.

By 1838, it looked as though the brilliant engineer might be out of a job. The London group of directors locked horns with their colleagues in Bristol over Brunel's future. But the ever eloquent engineer saved himself - and his high-speed railway.

It was a good job, too, for the Great

Western Steamship Co.'s flagship undertook its maiden voyage to New York in April 1838. The *SS Great Western* proved the genius of its creator by beating its nearest rival across the Atlantic.

The line from London Paddington to Bristol Temple Meads finally opened throughout on June 30 1841. The result is a testament not only to Brunel's engineering brilliance, but to his artistic flair.

But what makes the GWR main line a true wonder is that this futuristic taste of rail travel blends seamlessly into the landscape. Brunel strove to use local stone to match new railway structures with existing buildings. The railway through Bath's Sydney Gardens looks like it was just meant to be there.

### Key Facts

- Length:** 118 miles
- No. of stations (as at 1948):** 41
- Longest viaduct:** Wharncliffe Viaduct
- Longest tunnel:** Box Tunnel
- Steepest gradient:** 1-in-100
- Current operators:** Great Western Railway

**Did you know?**  
Eton College feared that a railway would bring moral corruption to its students. The GWR was not allowed to bring its route closer than three miles to the college, and it had to fence off four miles of railway to protect students. Eventually, a station was provided at Slough, and a branch to Windsor was built in 1849.



Under a tangle of overhead line equipment, GWR 800314 approaches Twyford with a London Paddington to Swansea service on September 18 2018. The Class 800s and Class 802s for GWR are built by Hitachi. MARK PIKE.



Box Tunnel is the longest tunnel on the Great Western Main Line at 1.83 miles long (2.95km). It is located between Bath and Chippenham and is Grade 2\*-listed. MICHAEL TUCKER/ALAMY.



# The Liverpool & Manchester Railway

**The LMR was so well-conceived that it laid down many standards for the railways we see today**

**P**alaentologists consider Archaeopteryx, the famous feathered dinosaur, to be the key link in the evolutionary chain between dinosaurs and modern birds. Railway historians have an equivalent: the Liverpool & Manchester Railway.

Before the Liverpool & Manchester, there were Tyrannosaur and Brontosaur-like plateways and waggonways. What came after the Liverpool & Manchester can be seen today, as clearly as the sparrows and starlings on your bird table - Britain's rail network.

Early railways were, generally speaking, all about one-way traffic. You owned a coal mine and you needed a quicker way to get your coal to the sea (or canal basin).

Coal would be dug from the ground, trains ran loaded one way, with empty wagons coming back. Others, such as the Surrey Iron Railway, were literally just a railed way. You could pay to use it, just as you would a toll road.

The Liverpool & Manchester Railway (LMR) would be different. Imported textile material would arrive in Liverpool. It would be conveyed to Manchester, be processed, and finished cloth would return to Liverpool for export.

This process was happening anyway, but using canals and turnpikes. The vision for the LMR actually fell to William James, a Warwickshire land agent and solicitor. A railway



## Key Facts

- Length:** 31 miles
- No. of stations (after 1844):** 30
- Longest viaduct:** Sankey Viaduct
- Longest tunnel:** Wapping Tunnel
- Steepest gradient:** 1-in-89
- Current operators:** TransPennine Express, Arriva Trains Wales

between Liverpool and Manchester was just one of the main routes he envisaged as part of a national railway network. Others included a line to link the key naval bases at Chatham and Portsmouth, or a Stratford-upon-Avon to London Paddington railway. But it was the line between Liverpool and Manchester that would come to fruition.

It nearly didn't. The Liverpool & Manchester Railway Company was formed on May 20 1824. However, James' initial route survey was not up to scratch.

Railway pioneer George Stephenson was given the job, but lacking the mathematical input of his son, Robert, the railway's first bill

## The Rainhill Trials

There were to be no horses hauling trains on the world's first inter-city railway. Steam power would rule, but would it be locomotives or stationary engines that reigned supreme? Trials were held at Rainhill in October 1829 and Robert Stephenson's *Rocket*, with its multi-tube boiler, proved victorious. But many of the other entrants and engineers, such as Timothy Hackworth, would go on to play an equally vital role in the development of the steam locomotive.

was thrown out by Parliament in 1825. The railway company employed John and George Rennie as chief engineers and their proposal received Royal Assent in 1826.

But then the Rennies fell out with the railway company and, once again, George Stephenson found himself in charge. He appointed noted engineer Joseph Locke as his assistant as he set about building a route very different to his own survey.

The resulting 35 miles of railway were quite unlike anything built before. There were 64 bridges and viaducts, many of which would be deemed 'world firsts'. The nine-arch viaduct that carried the line 21 metres (70ft) above the Sankey Valley, near Newton-le-Willows, is considered to be the world's first major railway viaduct.

Stephenson perfected the concept of the skew arch on a bridge near Rainhill. This had eluded some of the greatest canal engineers and enabled railway bridges to be built so much more effectively after.

And don't ignore the first cast iron girder

bridge, built on the outskirts of Manchester.

The greatest engineering headache was the miles of bog known as Chat Moss. Stephenson had dismissed using this marshy ground, but the Rennies adopted a route across it in an

An East Midlands Trains service crosses Sankey Viaduct over the Sankey canal on June 14 2018. JOHN DAVIDSON PHOTOS/ALAMY.

**Did you know?**  
The death of Liverpool MP William Husskison on the railway's opening day is well known. But what's not often recorded is that the first train to arrive in Manchester contained Prime Minister Arthur Wellesley. So unpopular was Wellesley in Manchester that the train returned to Liverpool immediately when confronted by an angry mob. The celebratory banquet was cancelled...

attempt to placate angry canal owners. Stephenson had no option but to cross it.

Initial thoughts centred on draining the bog. Instead, Stephenson floated the railway across on a bed of wood and heather, weighted down by rocks and stone. If you travel between Liverpool and Manchester today, that's what's keeping your train from sinking into the mud!

It's easy to overlook other engineering marvels, such as the 21-metre (70ft) deep rock cutting at Oliver Mount, on the edge of Liverpool or Wapping Tunnel, which gave the railway access to the docks and was the first tunnel dug under an urban settlement.

The Liverpool & Manchester set the standard for coupling configurations and the 4ft 8 1/2in track gauge. Oh, and talking of track, it was the world's first double-track railway.

The Liverpool & Manchester was a success from the day it opened on September 15 1830 until the day it merged with the Grand Junction Railway just 15 years later.

It was soon forced to expand beyond its initial Oxford Road (Manchester) and Crown Street (Liverpool) and soon sported grand termini in the form of Manchester Victoria and Liverpool Lime Street. It sparked the 'railway mania' of the 1840s when every town and city wanted its own railway.

But the Liverpool & Manchester did what no other railway might ever do again: deliver a profit of over 9% to its shareholders. ■

An illustration from the 19th century depicting navvies working on the railway across the Chat Moss bog. WORLD HISTORY ARCHIVE/ALAMY.



The Manchester Museum of Science and Industry, part of which used to be Liverpool Road passenger terminus. This closed in 1844 when the route into Manchester Victoria came into use. Goods traffic continued until 1975. DAVID CLOUGH.

# Ribblehead Viaduct

**An iconic structure that symbolises mankind's dominion over the landscape, this famous viaduct inspires with its sheer presence - and its past**

It was a close-run thing between Ribblehead Viaduct or the entire Settle-Carlisle Line winning a spot in *RAIL's* Seven Wonders of the Railway. But Ribblehead just beat its parent to the title.

A favourite with photographers of every kind, Ribblehead Viaduct (known in the past as Batty Moss Viaduct) carries the Settle-Carlisle Line through the famously scenic Ribble Valley in North Yorkshire. Opened in 1875, it took the Midland Railway five years to build what is the longest (400 metres) and third tallest (32 metres) construction on the 'S&C'.

The impressive structure was designed by John Sydney Crossley, who was the Midland Railway's chief engineer and responsible for all major structures along the route. Its construction was necessary to facilitate the railway's path across the difficult terrain of the

Yorkshire Dales, exposed as it is to the westerly winds. Building it was no easy feat.

Faced with limestone masonry brought from nearby quarries, the foundations of the viaduct had to be dug at depths of up to 7.5 metres (25ft) into the peat and clay, right down to solid rock. Steam-powered cranes were used to lift blocks of concrete into place, and the semicircular arches were made from a total of 1.5 million red bricks. It was a serious feat of engineering and sheer manpower.

Construction began in 1870 on the foundations for the viaduct (at the time being built by contractor William Henry Ashwell), but financial difficulties meant that just a year later the contractor was ousted and the Midland Railway employed its own labour.

Around 2,300 men were employed on the build, most of them navvies living with their families in shanty towns at the foot of the



Tourists flock to see the famous viaduct and to walk in its surrounding landscape. WAYNE HUTCHINSON/ALAMY.

viaduct. These temporary accommodations were given names such as Belgravia, Batty Green and Jerusalem, and they even had their own schools, libraries and pubs. Nonetheless, it was a dangerous job and more than 100 workers died during the project, usually either from falling from the tall structure or from ill-health afforded by their poor living conditions.

The loss of life on the build was so extreme that the railway company paid for an expansion of the local graveyard. Today a number of memorials along the line commemorate the lives of those who died.

Just two years into the project, the plan was expanded from a viaduct with 18 arches to one with 24, each with a span of 13.7 metres (45 feet). However, the work was duly completed

in 1874, and the first passenger-carrying train crossed it in September that year. But it was August the following year before the viaduct opened to freight traffic, and May 1 1876 before passenger services fully began.

The viaduct has endured many a trial over the years. By the time it reached its first centenary, it was falling into disrepair and many of its piers had become weak through constant beating from the Yorkshire rain. Between 1981 and 1984 steel rails and concrete cladding were added to strengthen some of the worst-affected piers, and further repairs were carried out in 1988-89, including the installation of a waterproof membrane.

It was famously threatened with closure (along with the whole of the 'S&C') during the 1980s, when British Rail became concerned by



A plaque listing the historic shanty towns that existed on the site during the construction of the viaduct. TONY LILLEY/ALAMY.

the high cost of repairs to its major structures, including Ribblehead. But campaigning by the Friends of the Settle-Carlisle Line saved the railway and the iconic structure from closure in 1989. It was then Minister of State for Transport Michael Portillo who stopped the closure from taking place, saying that the arguments had been weakened by an improvement in

passenger numbers and an overestimation of the costs of restoration work.

By then Ribblehead had also been Grade 2\* listed and the surrounding land where the workers had lived recognised as a scheduled ancient monument. A major restoration programme followed in the 1990s to protect the future of the line and its key structures.

Today, Northern operates regular services on the line, still providing a vital link across the Yorkshire countryside, and the route is popular with charter companies running special tours through the scenic landscape. But the viaduct also holds a special place in local tourism, with its stunning location a popular stop (for which laybys, a tea wagon and the *Station Inn* are provided).

For the many trials of its past to result in Ribblehead Viaduct being recognised as one of *RAIL's* Seven Wonders of the Railway seems a fitting stage in its long existence. ■

## Key Facts

- Length:** 400 metres
- Height:** 32 metres (104 feet)
- Spans:** 24
- Built by:** Midland Railway
- Opened:** August 3 1875
- Owner:** Network Rail

Clouds loom over Ingleborough beyond Ribblehead Viaduct, in classic Yorkshire Dales countryside on September 15 2018. MARK SUNDERLAND/ALAMY.

### Did you know?

The building of Ribblehead Viaduct provided the inspiration for the 2016 ITV period drama series *Jericho*. Set in the Yorkshire Dales in 1874, it tells the story of a family who start a new life in a remote town (Jericho), which is home to navvies, pioneers and vagabonds who live and die in the shadow of the viaduct they are there to build.



# St Pancras International



**Eurostar trains under the iconic Barlow roof on January 28 2017. JACK BOSKETT/RAIL.**

It is fitting that St Pancras International station should be named one of RAIL's Seven Wonders of the Railway in the year that it also turned 150 years old. The station has long been considered a marvel of Victorian Gothic architecture and engineering and is world-renowned for its unique beauty.

But it also has a fascinating place in British history and plays a vital part in the running of the modern railway. When the station opened in October 1868 (simply known as St Pancras station at the time), it immediately became famous for having the largest single-span roof in the world - the brainchild of designer William Henry Barlow. That roof is made from a series of wrought iron ribs that create a space 100ft high, 240ft wide and 700ft long.

This was no accident. It was built by the Midland Railway Company as a statement to outshine neighbouring King's Cross station (owned by competitor Great Northern Railway). For all the impressive features of the latter, the seemingly ecclesiastical splendour of St Pancras really does bring new meaning to the term 'cathedral station'. In fact, so deceiving is its architecture that it is said that in times gone by, an American tourist asked where he could find a place of worship and was directed to St Pancras Church. Mistaking the station for a house of God, he asked when the next service was taking place - and was presented with a list of departure times.

**Arguably the most spectacular railway building in the UK - the exterior of St Pancras International station. RICHARD WAREHAM FOTOGRAFIE/ALAMY.**

**Such is the magnificence of St Pancras that it's been mistaken for a house of God, if a well-known anecdote is to be believed. True or not, St Pancras is a shrine to the power of the railway**

It is sometimes difficult to fathom how this impressive structure has survived for 150 years. Enduring five bombs being dropped on or near the station during the First World War, the London Society suggested in 1921 that the station should be closed. Thankfully, these calls came to nothing. But then came the Second World War and the station suffered yet more damage. After the war, road transport was taking over and in 1966 British Rail proposed to demolish the station.

A successful campaign led by the poet laureate John Betjeman and architectural historian Nikolaus Pevsner put paid to that when the station received Grade 1-listed status in November 1967.

It is Sir John Betjeman (a statue of whom adorns the upper concourse

today) who truly captures the romance of St Pancras in his writing of it: "What the Londoner sees in his mind's eye is that cluster of towers and pinnacles seen from Pentonville Hill and outlined against a foggy sunset and the great arc of Barlow's train shed gaping to devour incoming engines, and the sudden burst of exuberant Gothic of the hotel seen from gloomy Judd Street."

In 1993, a turning point was reached in the station's future when the Government decided to plan a high-speed route from the Channel Tunnel to St Pancras... what is now High Speed 1.

## Key Facts

**Opened:** October 1 1868  
**Relaunched:** November 6 2007  
**Designer:** William Henry Barlow  
**Train shed height:** 5 metres (17ft) above street level  
**Managed by:** Network Rail (for HS1 Ltd)

An £800 million restoration enabled the station to be reborn in 2007 as St Pancras International - UK rail's gateway to Europe. The modernisation took three years and doubled the length of the station, adding six new platforms. More than 5,000 individual contractors were involved in the transformation, which also became a catalyst for several billion pounds' worth of regeneration in the Camden area.

HS1 Ltd holds a 30-year concession to operate the station, along with the rest of the high-speed route it serves, and employs the services of Network Rail (High Speed) - a subsidiary of NR - to manage it. Today, the station is not only the terminal for Eurostar services from the continent, it also handles East Midlands Trains and Thameslink services to Corby, Sheffield and Nottingham on the Midland Main Line and Southeastern high-



**A statue by Martin Jennings of poet Sir John Betjeman on the Upper Concourse of the station. EDWARD WESTMACOTT/ALAMY.**

speed trains to Kent, as well as Thameslink cross-London trains.

According to the Office of Rail and Road, St Pancras is in the top ten most-used stations based on passenger entries and exits. In 2016-17 there were 33,492,476, taking the station up from its ranking of 11th place the previous year.

You could write a book about all the interesting and quirky facts about this impressive station (and many have), but sadly there is not space here to wax lyrical about the unit of measurement for the station's columns being the length of a beer barrel, or the fact that Fortnum & Mason keeps bees on the roof... those stories will have to keep for another day. Until then, let us be glad this 150-year-old masterpiece is still standing to delight many more generations of visitors. ■

## Did you know?

According to the Roman Catholic church, Pancras was born in Phrygia (modern-day Turkey) in about 290AD. A 14-year-old orphan, he was brought to Rome, where he converted to Christianity. He was martyred in 304AD by Emperor Diocletian for refusing to denounce his faith. The belief is that Pope Vitalian sent his relics to England to spread Christianity, including to St Pancras Old Church in Camden, from where the station takes its name.

# West Highland Railway Extension (Fort William-Mallaig)

**A**ugust 19 1745: Charles Edward Stuart raises the banner of the ancient house of the Stuarts at a remote spot of Glenfinnan, at the head of Loch Sheil.

It's a pivotal moment in British history. Stuart's Jacobite army would march south (as far south as Derby, in fact) before retreating to Culloden, near Inverness. Defeat here at the hands of the Hanoverian army in 1746 would end the Stuarts' claims on the British

**A Jacobite steam service crosses Glenfinnan Viaduct in the Finnan Valley on June 28 2017. Probably the most well-known and best-loved location on the route. NICKY BEESON/ALAMY.**

**Considering the financial shortcomings and strife in its history, the WHR seems to exist almost purely because of the beautiful landscape through which it runs... and a little magic**

throne and radically alter the traditions of the Highlands for generations to come. The raising of the Stuart banner at Glenfinnan is marked by an 18-metre (60ft) high monument, erected in 1814, which becomes a place of pilgrimage to hundreds of 'Jacobite' enthusiasts every year.

But the monument is now overshadowed by another structure. Standing 30m (100ft) high, the drab concrete edifice attracts hundreds of visitors a day during the summer months, all making a different type of pilgrimage thanks to

the silver screen antics of a student wizard, a red Great Western locomotive and a 1960s Ford.

Even if you're not a fan of J.K. Rowling's best-selling *Harry Potter* books, you cannot deny the positive attention that the 'Hogwarts Express' has garnered for a railway that, in the 1960s, was only saved by the promise of 200,000 tonnes of freight traffic a year from Scottish Pulp (Development) Ltd's new plant at Corpach.

The West Highland Railway opened in August 1894. That simple sentence hides the trials and

tribulations that the railway builders underwent to construct the line from Glasgow Queen Street to Fort William. But what a railway!

The biggest argument for the construction of HS2 is that it will bring prosperity to deprived areas of the country. This is not a new argument, and the Victorians built many miles of railway to rejuvenate flagging industries, but all they managed to tap into were traffic flows that never materialised.

The Highlands were some of the most deprived areas of Britain in the 1890s - so much so that in 1892, the Government sent a committee to seek out the best ways to bring

## Key Facts

**Length:** 41 miles 28 chains  
**No. of stations (after 1985):** 10  
**Longest viaduct:** Glenfinnan  
**Steepest gradient:** 1-in-40  
**Current operators:** ScotRail, West Coast Railway Company



The Jacobite steams through from Fort William to Mallaig on October 8 2011, showing just how spectacular the scenery is on this line. JOHN DAVIDSON/ALAMY.

help to the area. The locals believed a rail connection to Mallaig Bay would be ideal.

The North British Railway, which operated the West Highland, wanted nothing to do with a railway that would go west beyond Fort William, despite crofters offering their land for the railway well below market rate and offering their services as navvies.

The West Highland Railway believed, in the face of physical evidence, that the West Coast fishing trade could become a lucrative source of revenue. The West Highland (Mallaig Extension) bill was passed by Parliament and the first sod was cut at Corpach on January 21 1897. What made this railway different was that it received government funding: shareholders received a guarantee on investment and a £30,000 grant was made towards the construction of the pier at Mallaig.

It's somewhat ironic that the Tories approved of public subsidies for transport but the Liberals did not, expressing horror at the 'free gift' being handed over to railway promoters and their shareholders.

Construction was one of the most arduous in railway history. Contractor Sir Robert McAlpine's son Malcolm nearly became one of the many casualties.

McAlpine was able to keep costs down and live up to his 'Concrete Bob' nickname by using this material for the majority of the bridges and viaducts. This included the delicate-looking 21-arch 1,248ft-long structure that curves above

the Finnan valley at a radius of 12 chains (241.4 metres). When the Extension opened in 1901, Glenfinnan Viaduct was the world's largest railway structure built from concrete.

The extension is a railway of contrasts. The Gulf Stream allows palm trees and sub-tropical plants to flourish near Arisaig. How is it possible that this meets the same railway that crosses Rannoch Moor?!

There are so many classic locations and landmarks on the Extension that it's impossible to list them all. The straightest section

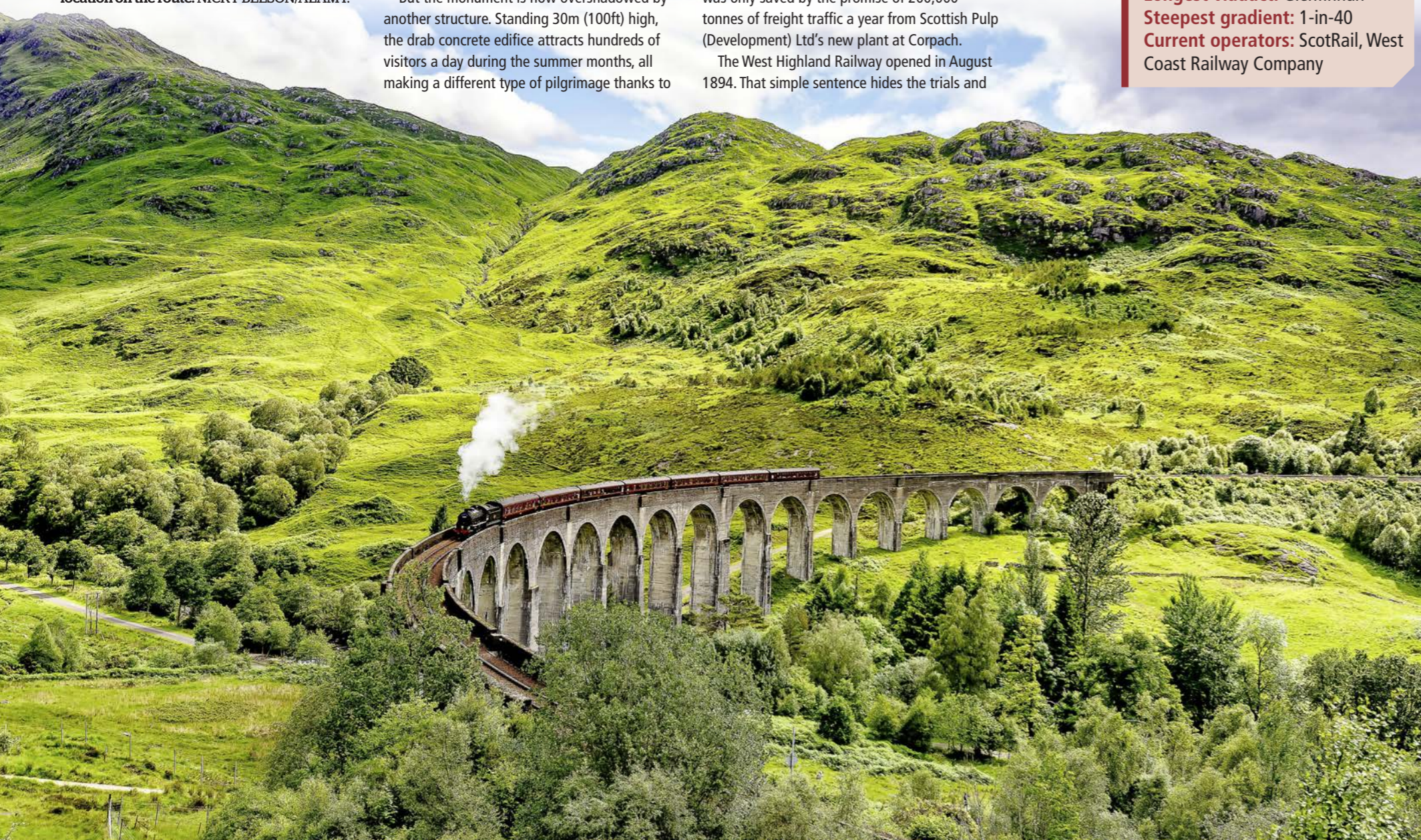
of track is along Loch Eil. Along this stretch, the line crosses the Caledonian Canal at Banavie, with the eight lock gates of Neptune's Staircase stretching up the hillside.

The Extension looked financially doomed from the off. Receipts never exceeded expenses, although it came close in

1911-12 when the line only lost £2,017 12s. The steam-hauled 'Jacobite' service has helped save the West Highland (Extension), with January and February being the only months when the 'Road to the Isles' isn't laden with hordes of tourists.

The West Highland (Extension) is one of the few railways to bridge the gap between railway enthusiast and the general public. Do your children or grandchildren scoff at the chance to ride the railway? Tell them that they're taking the train to Hogwarts, and see their eyes light up. The West Highland Railway - it's a magical experience. ■

**Did you know?**  
Contrary to popular belief, a horse and cart didn't fall into the uncompleted pier of Glenfinnan Viaduct. The remains of the horse and cart were actually found in Loch nan Uamh Viaduct by Roland Paxton in 2001.



# Visit the Seven Railway Wonders

By Barry Doe



I appreciate we have readers all over Britain, so no itinerary to visit the Seven Wonders can really be put together to suit you all without knowing a starting point.

After all, if you live in Mallaig a tour of the seven is going to be very different for you than for those living in Margate! And those living in the middle of England might find it easier to go out and back to some of them, rather than do a tour.

However, I'm going to suggest a sequence, with no bias, starting in Bristol. No doubt most readers can at least plug into it at some point.

## 1 Great Western Railway main line (London-Bristol)

This route is one of Brunel's greatest achievements. The best parts are Temple Meads itself (pictured), the first 24 miles to Chippenham via Box Tunnel, and the Thames stretches from Didcot into Paddington at the eastern end. Having reached Paddington, use the Hammersmith & City Line to reach Euston Square for Euston and the Caledonian Sleeper to Fort William.



NETWORKRAIL

## 2 West Highland Railway Extension (Fort William-Mallaig)

The Sleeper is a wonderful experience. Ensure you're up around 0700 to sample the West Highland scenery from your berth or the lounge car.

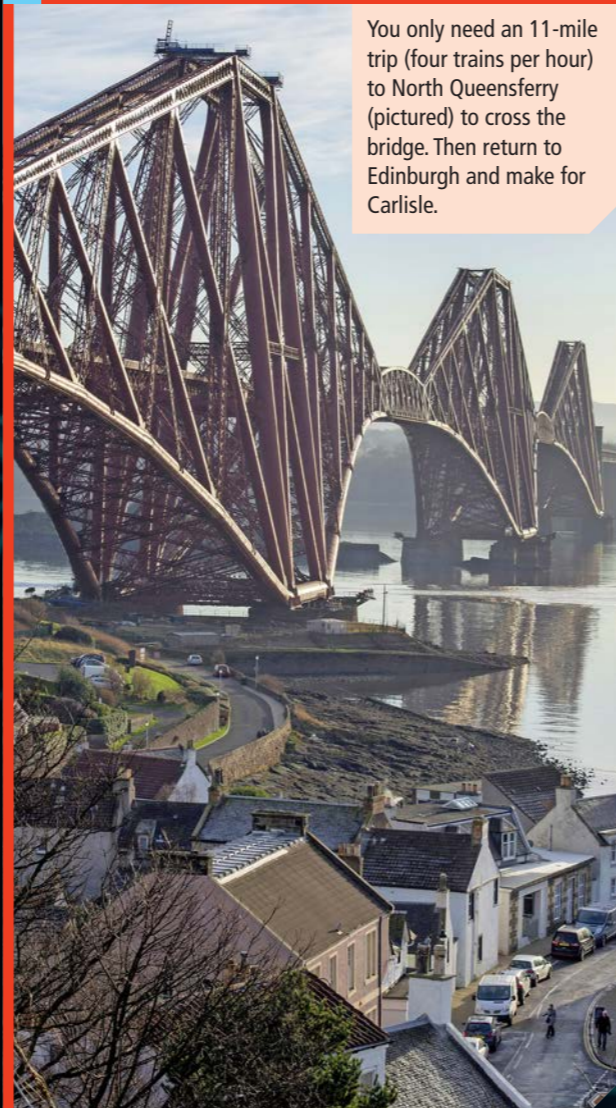
You then do a return trip on the Extension proper, to Mallaig. In summer you could use the steam train one way. On your return you'd then make your way to Edinburgh. You could use the special day coach attached to the 'Up' Sleeper for this, but as it arrives 0110 it's better to stay overnight somewhere en route.



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## 3 The Forth Bridge

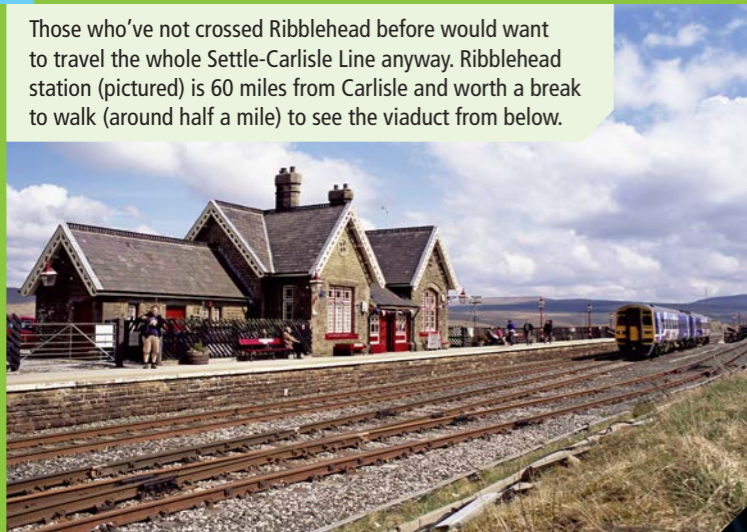
You only need an 11-mile trip (four trains per hour) to North Queensferry (pictured) to cross the bridge. Then return to Edinburgh and make for Carlisle.



ALAMY

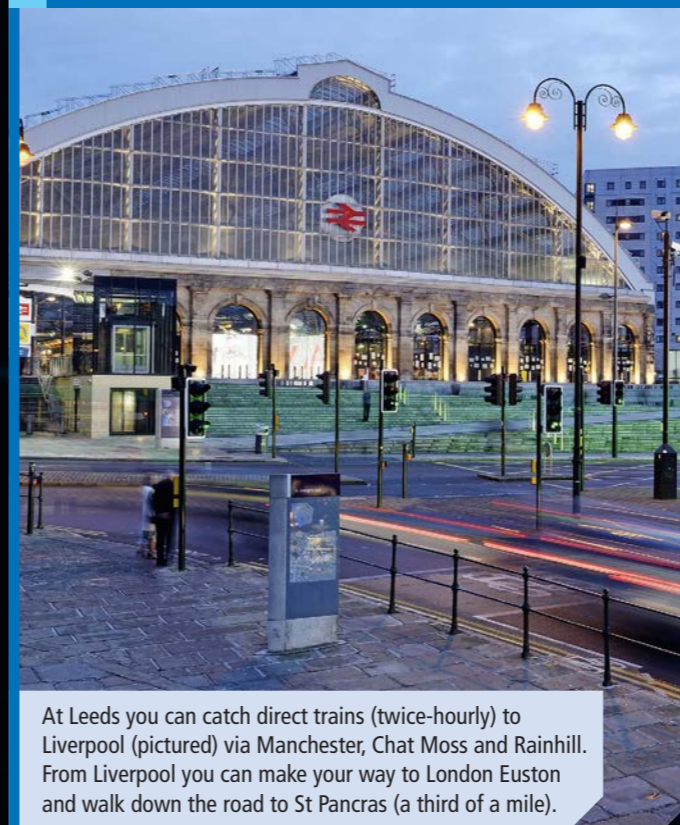
## 4 Ribbleshead Viaduct

Those who've not crossed Ribbleshead before would want to travel the whole Settle-Carlisle Line anyway. Ribbleshead station (pictured) is 60 miles from Carlisle and worth a break to walk (around half a mile) to see the viaduct from below.



KEITHDONGATE

## 5 The Liverpool & Manchester Railway

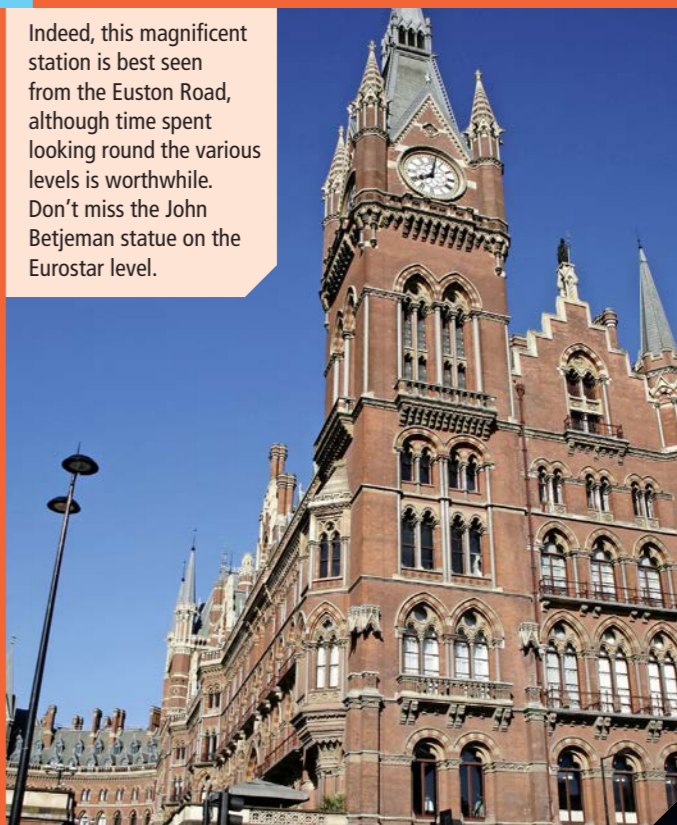


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At Leeds you can catch direct trains (twice-hourly) to Liverpool (pictured) via Manchester, Chat Moss and Rainhill. From Liverpool you can make your way to London Euston and walk down the road to St Pancras (a third of a mile).

## 6 St Pancras International Station

Indeed, this magnificent station is best seen from the Euston Road, although time spent looking round the various levels is worthwhile. Don't miss the John Betjeman statue on the Eurostar level.



ALAMY

## 7 The Channel Tunnel

It's from here that your train will depart to pass through the Channel Tunnel. In theory Calais is the shortest trip, but as the service is slender you might as well do a trip to at least Lille, if not Paris or Brussels.

### Fares

It's impossible to quote fares as it depends when you travel and where you break. You could easily do this in a week and use an All-Line Rover, starting at £510 - but you'd still have to pay separately for Eurostar (plus Sleeper room-fees). It's probably best looked at in legs, possibly with advance tickets and an inclusive berth & travel fare on the Sleeper. Use [www.brfares.com](http://www.brfares.com) to get ideas that suit where you live.



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