

# Early History of the Sapperton Railway Tunnels

The biggest obstacle to the railway between Swindon and Gloucester was undoubtedly the Cotswold escarpment near Sapperton. The solution put to Parliament in 1836 was a tunnel 2830 yards (1.61 miles) long. Although the average gradient up to Stroud was kept to a very tolerable 1 in 352 the alignment of the tunnel was curved throughout its entire length as shown by the green line on the map below.

It appears that the curve was objected to in Parliament. This was possibly because it was thought that derailments would be more likely to occur on a curve and the consequences of a derailment in the tunnel might be very severe. In the event the Act to build the line was passed in 1836. However, a second Act was sought in 1838 to allow a 'deviation' of the tunnel alignment from that laid down in the 1836 Act. Two alternative lines were proposed by Brunel. The first shown in blue on the map was so similar to the 1836 proposals that it is difficult to see what he was hoping to achieve. The second proposal was authorised by the 1838 Act. This took an almost straight line through the hill with the penalty that the line entered the escarpment at a higher level than the 1836 alignment. Consequently, the approach to the tunnel was at a marginally steeper gradient (1 in 330) and a slightly shorter length of 2730 yards (1.55 miles).

It is not clear whether any work ever started on the alignment approved by the 1836 Act and the available documentary evidence suggests it did not. However an archaeological investigation carried out a few years ago and reported in the Gloucestershire Society for Industrial Archaeology Journal for 1998 suggests that a large stone wall found in the vicinity may have been built as a retaining wall for the proposed works.

Work on the shafts for the tunnel approved in 1838 had started by May 1839. A contract for about £8000 was let early in 1841 to sink four additional shafts and to drive the headings between them at the level of the intended track. This did not include opening out the narrow headings into the full bore of the tunnel. Work continued and most of the headings were completed by 1843 although interestingly no headings were driven from what would be the two entrances to the tunnel. It has been suggested this course of action was to delay purchasing the land at the two entrances!

# Completing The Tunnels

In 1843 the Great Western Railway company took over the beleaguered Cheltenham & Great Western Union Railway company. The decision was made to further cut costs by siting the tunnel at an even high level than the one started but on the same line and of course using the same vertical shafts. As the line 'on the ground' had not altered there was no need to seek authorisation of a 'deviation' from Parliament.

Unfortunately this really did make a big difference to the gradients on the approaches to the tunnel. The modest gradients that had been quoted previously appear to have been the average gradient from Stroud to the tunnel. However, the first part of the route up to Chalford involves considerably less climbing than the second part up the Golden Valley beyond Chalford.

The effect of the elevation of the line in the tunnel meant that the true gradient of the latter part of the approach from Stroud had become a demanding 1 in 60 and the first 80 yards in the tunnel was actually 1 in 57. Furthermore, the increased height meant that there would now be two tunnels not one as the summit level was now in a cutting which separated the two tunnels by about 100 yards. The western tunnel has always been known as Sapperton 'Long' and the eastern one Sapperton 'Short'. It is possible to look down into the cutting from the road bridge at the point where the A419 road between Stroud and Cirencester crosses the railway.

After the first 80 yards the line climbs the remainder of the 'Long' tunnel at 1 in 90 and descends through the 'Short' tunnel towards Kemble at 1 in 95 (see the cross-section on the next display panel).

Throughout the age of steam, most passenger and goods trains required assistance to climb the 1 in 60 approach to the tunnel and two locomotives were kept at Brimscombe station especially for this purpose. They were always referred to as 'banker' engines as their role was to push the train 'up the bank'!

# Problems

The surviving lower parts of the shafts below the line of the railway were closed off when the present tunnel was driven. However, it was inevitable that the timbers that formed part of the capping would eventually decay. This caused problems on more than one occasion. In November 1954 a driver of a Gloucester to Paddington steam train reported that he had 'felt a bump' in the tunnel. On investigation it was found that the lower part of shaft 2A had opened up leaving a 15ft drop down towards the line of the abandoned 1841-43 heading. The tunnel was closed for four days while the shaft was recapped and the state of all the other shafts checked. Since then a lot of extra capping of the shafts has been carried out.

## 19<sup>th</sup> Century Tunnelling Techniques

The construction of the Sapperton Canal Tunnel (1784-1789) and Railway Tunnels (1839-1845) were major engineering feats of their age and on a par with the construction of the Channel Tunnel in recent times.

To construct a tunnel more than a few hundred yards in length it was usual to sink a series of vertical shafts from the surface and then work outwards from the bottom of the shaft. Great skill was required to both establish the correct level underground and then the direction to bore the tunnel. An early method of determining the direction to tunnel was to suspend two plumb lines in the shaft. These were then lined up at the surface in the direction of the proposed tunnel. Heavy weights at the ends of the lines were immersed in tubs of water at the bottom of the shaft to stop the plumb lines from swinging. A lighted candle at the tunnel face was kept in line with the two plumb lines and hopefully the required direction was maintained.

Later and certainly during the time that the Sapperton railway tunnel was built it was usual to use a mariners compass to determine the direction to tunnel. Either way, great skill and much checking would be needed to ensure that the different sections of the tunnel would meet up. There are reports of tunnels that were only inches out in a distance of 500 yards – a truly remarkable achievement.

Once the heading had been driven the tunnel could be opened out to full size. Some means had to be contrived with props and stays to prevent the roof from falling in until the newly cut section could be lined with masonry or brick.

Tunnelling was a most hazardous job. The men were working deep in the earth soaked by muddy water and at risk from their own explosions. They normally worked 12 hour shifts, using hammer and chisel by candlelight, and had to endure foul air for much of the time. Sometimes as many as 600 men would be employed on a project.

The vertical shafts were typically 10-20ft in diameter. Men were lowered down the shafts in buckets and the soil and rock brought up the same way. The spoil was deposited at the top of the shafts as can be seen today at the top of both the railway and canal tunnels.

# The Tunnels Today

The length of the 'Long' Tunnel is 1855 yards (1.05 miles) and that of the 'Short' tunnel is 353 yards (0.20 miles) giving a total length of 2208 yards (1.25 miles) excluding the short summit cutting. Each of the tunnel entrances lies in a fairly deep cutting. The one on the approach from Stroud up the Golden Valley is a full 64ft and on the gentler slope on the Kemble side it is 47ft.

No doubt in many respects the tunnel is little changed since it was inspected in early May 1845 by General Pasley, Inspector General of Railways for the Board of Trade. He was accompanied by Brunel's resident assistants R P Brereton and Charles Richardson.

The tunnel was cut through great and inferior oolites and the fuller's earth formation with shale and beds of shelly limestone. The rock was described as being of an unsound quality with many wide and deep horizontal and vertical fissures partly filled with clay and earth. It was therefore necessary to line the tunnel throughout with masonry and brickwork. The cross-section of the tunnel was referred to as being of an 'oblong segmental ellipse' and was wide enough for a double broad gauge track. In one area it was deemed necessary to construct an 'inverted arch' in masonry below the level of track for a distance of 443 yards. Presumably it was considered that there was a threat of the tunnel collapsing inwards below the level of the rails.

It had a maximum width of 28ft at a height of 7ft above the rails (and a width of 27ft at the actual height of the rails). The sidewalls are constructed of masonry and are generally two feet thick. The roof of the arch (above the height where the span has decreased to 20ft) is built of brickwork. This has a varying thickness of 18-27in, that is two to three bricks thick. At the time of the inspection it appears that only one of the 10 shafts was open. Today shafts No 3 and No 4 are open but protected by tall blue engineering brick circular enclosures.

The tunnel and its track are regularly inspected and certainly in the past the open air shafts were periodically inspected by lowering an engineer down to examine the brickwork.