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Watch Out for the Gradient

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The rack assisted BRB has its own signing system. This shows the start of a 250‰ (1:4) climb.

The road sign for the steepest gradient on the Swiss PostAuto network climbing from Tschingel (near Spiez) to Griesalp.

Photos: Bryan Stone

A standard Swiss gradient sign at Brienzwiler on the ZB showing the line falling at 3‰ for 913m.

While reading recent issues of *Swiss Express* I have several times had cause to raise an eyebrow at the way in which gradients of various railways have been (mis)stated. I will not embarrass the various authors by being any more specific! The matter, though, has led to a reconsideration of my own understanding of the topic.

Gradients are measured by comparing 'rise' to 'run', where rise is a vertical distance and run is the corresponding horizontal distance. This gives us such measurements as 1 in 4, familiar to many motorists on warning signs, and 1 in 37, the gradient of the well known climb from Exeter St Davids to Exeter Central. The use of such measurements on UK roads is in decline, being superseded by a percentage - so 1 in 4 becomes 25%. On the railways of Britain, though, the 1 in xx format holds sway and is frequently displayed on gradient signs alongside the tracks. The Exeter incline is seldom given as 2.7%! However, most European railways, including those of Switzerland, use the percentage system or something closely akin to it, and this system is also used on Swiss roads.

This is where confusion sometimes arises, particularly when using both the British and European systems together for comparison, and perhaps at the same time introducing the angle of slope as would be indicated by a protractor. A slope of 45° by definition has a gradient of 1 in 1, which is 100%. There is a temptation to think of 45° as 50%, because it is half way between horizontal and vertical, but this is clearly incorrect.

Gradients on main lines have to be modest as trains are often long and heavy and have only a limited number of powered axles. The Lötschberg summit and Gotthard routes represent extreme examples, where additional traction is sometimes called for, with gradients reaching 2.7%. This matches Exeter but applies over a much greater distance. Elsewhere lines are usually much less steep than this. Secondary lines frequently use lighter, multiple unit trains with a higher proportion of powered axles. This allows them to climb surprisingly steep gradients, purely by adhesion. The Uetlibergbahn (standard gauge) in Zürich has a maximum gradient of 7.9% while the MOB (metre gauge) climbs out of Montreux at 7.3%. Rack assistance is usually required on gradients above about 8%. The Riggenbach, Abt and Strub systems, (and their derivatives), permit the use of gradients up to about 25%. Above this, there is a danger of the pinion climbing out of the rack. The Pilatusbahn was built with gradients of 48%, for which Locher designed a special rack system. This proved to be eminently successful but was not used elsewhere. Despite its world record status, the Pilatusbahn is still less than 1 in 2, or a slope of about 25°.

Switzerland has about fifty public funiculars, usually short, steep lines employing two counterbalanced cars. Some were built as, or modified to, single car cable-hauled inclined lifts, which for convenience are usually still regarded as funiculars. Gradients vary from 0%, for example on the lower section of the Fun'ambule in Neuchâtel, through to 80%, and more. Since opening to the public in 2001, the steepest funicular in Switzerland has been the one-car Gelmerbahn at 106%, or an angle of just over 46.5°. It will lose its status when the new Schlattli - Stoos funicular opens. This will be the steepest two-car funicular in the world with a maximum gradient of 110%. To put matters in perspective, steeper still is the funicular at Katoomba in Australia. The maximum gradient here reaches 122% but, as with the Gelmerbahn, it has only a single car.

There has to be a sting in the tail, of course. Railway

gradients in Switzerland are generally given as per mille (‰) rather than per cent (%). This is a concept unfamiliar to many British readers, so much so that it is not even particularly straightforward finding the symbol on the computer. In essence, though, it is a very simple idea as it gives the height 'rise' in metres over a 1km 'run'. So, for example, 0.5% gradient (where a line climbs 5m over 1000m) is shown as 5‰. The advantage is the elimination of the leading zero and the decimal point, making sighting less prone to error.

There are no UK style railway gradient posts in Switzerland. Instead, boards giving an indication of gradient change are be attached to electrification masts, etc., facing oncoming trains. They are not very conspicuous to the casual observer and are rarely photographed. The boards are shaped to point up or down as appropriate and carry two numbers. The bold number nearer the pointer indicates the gradient per mille (‰), whilst the second number, displayed in smaller digits, shows the length of the gradient in metres.

A representation of the gradient board at Mühlenen. The line is shown to rise at 8‰ for 470 m.

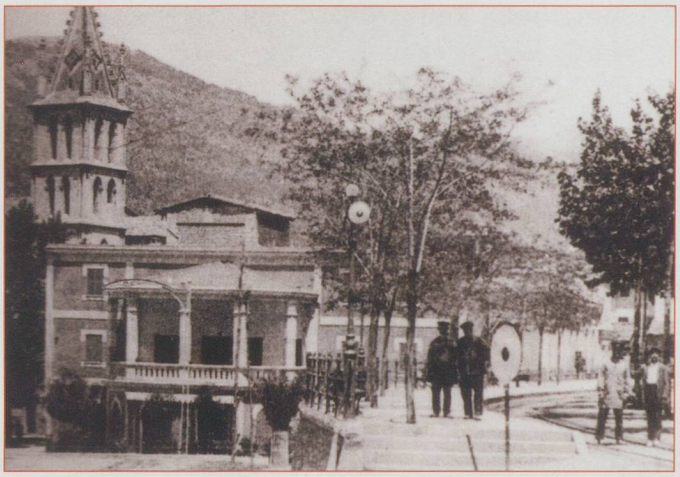
A representation of the gradient board at Le Brassus station. The line falls at 14‰ for 379 m

Oldest Station Building?

Some follow-up from our members

Photos: David Noel Collection

Soller station front. The house as was, but changed to become the station with the booking office, etc. inside.



Soller station platform. Back of the house now the station with one platform. The veranda is now a cafe.

As he did when he raised the question of asymmetric bogies in a recent edition of *Swiss Express* our regular correspondent Ron Smith has again opened up a whole new can of worms with his article on the station building at Grafenort on the Zentralbahn, formerly the Luzern Stans Engelberg Bahn (LSE). Ron noted that the building used as the station was originally built in 1690 by the enormous monastery in Engelberg as a 'Herrenhaus' to be used as a summer retreat for the monks.

First off the mark to challenge this was Geoffrey Bryson who noted that his 1993 edition of '*The Guinness Book of Railway Facts and Feats*', listed Cuautla, south of Mexico City, as having the world's oldest railway station. The Mexican station was originally built as a convent in 1657 until it was secularized in 1812, then becoming a station when the railway was opened in 1860. In its original use the building was catering for the needs of New World Catholic women for 33 years, before Old World Swiss Catholic men could go to Grafenort on holiday! It also had seen 38 years of use as a station before the LSE's predecessor the Stans Engelberg Bahn opened its facility in the Herrenhaus in 1898.

Whilst your editor was digesting this information along came David Noel (and others) informing him that the station building at Soller on Majorca was originally built as a grand town house, probably for a wealthy merchant, in 1616. One side of the building serves as the station for the line from Palma, whilst the other side is the departure point for the historic tram to Port Soller. Apart from having a booking office and other facilities inside, the building also serves as a café that apparently is a peaceful and shady retreat once the trains depart. So we now have pushed back the oldest station building by 74 years. Does anyone out there know of an older building?

Appears not to have changed much since becoming a station. The tram in front goes to Port Soller.