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The Crocodile celebrates its centenary this year

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An SLM works photograph of Ce 6/8[II] 14251 taken in 1919. For the first few months this locomotive carried the pre-1920 classification Fc6/8 and was numbered 12251.

All Photos: ©SBB Historic

Part One

One hundred years ago the electrification of the Gotthard line was underway and an electric locomotive powerful enough to haul heavy freight trains over its fearsome 26‰ gradients was urgently required. Circumstances were not propitious. Swiss industry was hampered by lack of materials and personnel, a consequence of the recent great European conflict. There was no time for extensive testing of prototypes but the solution that was produced was not only an instant success, it was a design masterpiece that gave over half a century of front line service to the SBB. It also became an instantly recognisable classic, an icon for railway enthusiasts the world over. They were not eclipsed until the arrival of the post-war universal locomotive, the equally iconic Ae6/6.

This article describes the design and construction of the legendary Crocodile and its history to the end of the 1920s. A second article to appear in the December *Swiss Express* will devote itself to the 1930s, their autumn years, eventual withdrawal and, for a lucky few, preservation. However readers should note now that on 19th October next, SBB Historic will have all three serviceable Crocodiles 14253, 14305 and 13302 in service over the Gotthard from Erstfeld to Bellinzona and back to celebrate 100 years of the legendary "Crocodile" locomotive.

Specification

Four prototype locomotives had been ordered from Swiss industry in 1918 (Note 1). One of them was intended for freight traffic over the Gotthard and was originally intended to have no carrying axles. However, carrying axles were found to be necessary and this prototype became class Ce6/8 12201 (later 14201). Time pressure meant an order for a production series had to be made before any of the prototypes were delivered.

The specification that SBB had produced was demanding. It included the following:

- The capability to haul a train of 860 tonnes from Arth-Goldau to Chiasso and back, twice (a total of 700 kilometres), within a period of 28 hours. (Assistance to be provided on a gradient exceeding 10‰.)
- The capability to overcome the steepest gradient of 26‰ with a train of 430 tonnes at 35 km/h or 300 tonnes at 50 km/h.
- A top speed of 65 km/h to be achieved on a 10‰ gradient with a 300 tonne trailing load.

Concept

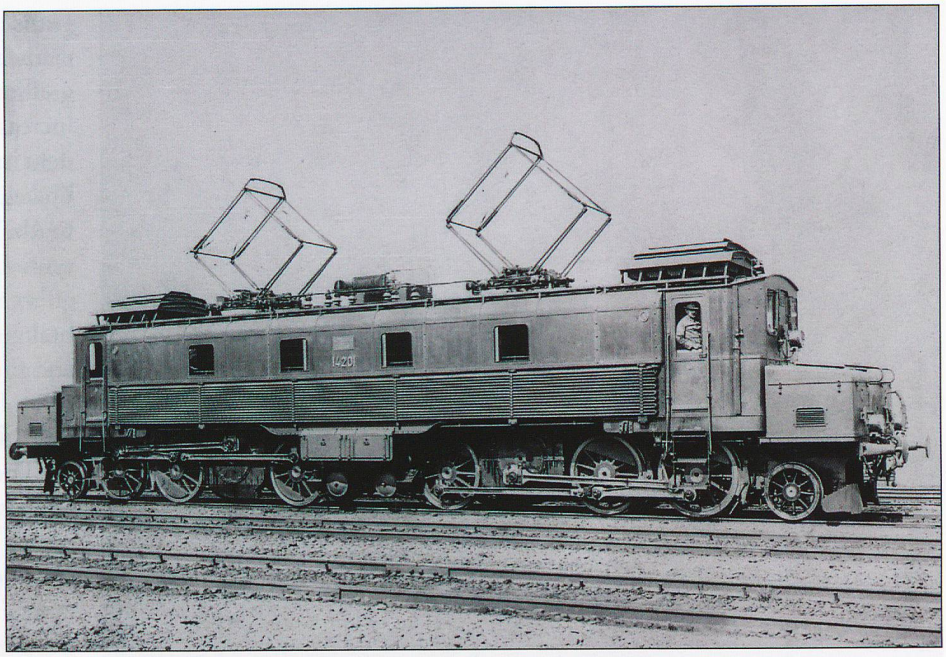
Engineers conceived of an articulated design for two reasons:

- Axle load limitations dictated that mechanical and electrical components be distributed over a large number of axles.
- The curvaceous nature of the Gotthard route required flexibility.

The mechanical arrangements differed from the prototype locomotive 12201/14201 and reflected steam practice with two back-to-back frames each containing three driving axles and connected to each other by a heavy duty coupling. Two electric motors would each be housed in bonnet sections forming the outer ends of each of these frames. Through

helical gearing each pair of electric motors would drive a layshaft positioned between them. From that layshaft a triangular coupling rod, supported by a second layshaft in front of the first driving axle, would transfer the output to the first pair of driving wheels. Then coupling rods would pass the drive on to the remaining driving wheels. A leading pony axle would assist movement through curves.

Over the inner ends of each frame and supported by pivot bearings a central higher section would sit. Here would be housed the electrical equipment and at each end a driving cab. The result would be an articulated machine approximately 20 metres long, weighing around 128 tonnes that guaranteed good mobility over curves and reduced track wear. It was of course the flexibility through curves and the long nose at each end that quickly earned the locomotives the nickname "das Krokodil" or the Crocodile. The main difference between the prototype locomotive 12201 (which became Ce6/8^{I}) and the later series productions was the size of the central body and the nose sections. This difference was occasioned by the drive which, on the prototype loco, had the layshaft positioned between the second and third driving axles. On the production machines, the layshaft was between the first and second driving axles and the motors were therefore further forward. This caused the central body to be much shorter and the noses at each end to be much longer.

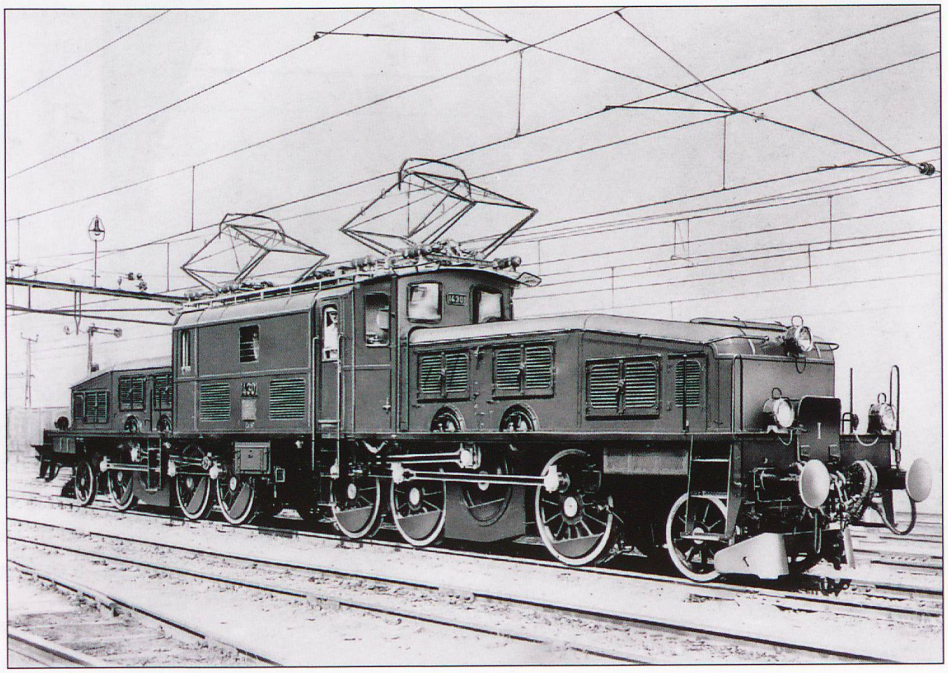


An SLM works photograph of prototype Ce 6/8 14201.

First Series

In 1918 an order for 33 machines was placed with Schweizerische Lokomotiv- und Maschinenfabrik (SLM) in Winterthur for the mechanical erection and to Maschinenfabrik Oerlikon for the electrical components. These formed class Ce 6/8^{II} Nos. 14251 – 14283. They were delivered over the period 1919 to 1922. At first they carried a livery of cinnabar red and vermillion with a black chassis but this soon became dirty and SBB switched to chocolate brown. In 1928 they started to receive their definitive pine green appearance with grey underframes.

After their delivery to SBB the first Crocodiles were placed in service between Bern and Spiez, a section of the BLS that had been energised in 1919. As electrified sections of the Gotthard line were progressively opened between 1920 and 1922 they then appeared on the route for which they were designed.



An SLM works photograph of Ce 6/8^{III} 14301 taken in 1926.

Innovative Electrical Equipment

At the time the Crocodiles were built, research and development in railway electric traction was progressing quickly. With the agreement of SBB, developments were incorporated into the fleet as it was being built. As a result there were significant differences between locomotives, a positive development at the time but something of an annoyance to maintenance staff in later years who had to be aware of the peculiarities of each machine and the correct repair procedure.

Between each cab were housed the transformers, main switches and tap changers. The transformers could be fed with either 7,500V or 15,000V single phase AC at 16.7Hz from the two diamond pantographs on the roof. In the 1920s with steam operation still continuing, soot build up on the catenary and smoke hanging in tunnels were problems. To mitigate the risk of flashovers and short circuits

A Ce 6/8III is seen here with a goods train conveying foodstuffs at Liestal in 1936.

the catenary in the tunnels was fed with only 7,500V at the outset.

Speed was controlled with electro-mechanical tap-changers providing 23 notches. This noisy equipment was only separated from the cab by a removable sheet metal plate and throughout the locomotives' existence drivers had to contend with flashovers, short-circuiting and spark spitting directly behind their backs!

Modern braking equipment

Innovation could also be seen with the brakes. At SBB's request the Ce 6/8II was equipped with an early form of regenerative brake developed by MFO's Chief Engineer, Hans Behn-Eschenberg (1864-1938). Sufficient energy could be recovered on a falling gradient to brake the locomotive. This increased safety as there was now an independent system to the mechanically applied air brakes. Recuperative braking also reduced wear to the locomotive's brake blocks and wheel tyres. In comparison to today's locomotives the effect was limited, but drivers would usually brake the locomotive with the electric brake and the train with the air brakes.

Spacious Cabs

The cabs were originally laid out for operation by two crew members, who would work from a standing position to enable them to look forward through the relatively small front windows. There was a further small window over the driver's desk that allowed the crew to peer into the illuminated bonnet section to ensure, by sight, sound or smell, that all was well with the motors. To protect against cold at the driving position, heaters and foot warmers were provided. Throughout the period before the Second World War SBB allocated a dedicated drivers to locomotives, a practice carried over from steam days, to encourage greater care by the driver.

A Second Series

The rapid progress of Swiss railway electrification during the 1920s produced a requirement for further heavy freight locomotives. As the first generation of Crocodiles had proved itself so well, the SBB remained true to type and ordered a second series from SLM and MFO. This became class Ce6/8III. The manufacturers built on their latest experience and produced a machine with an hourly rating of 1800 kW as compared to 1650 kW with the Ce 6/8II.

During 1926 and 1927 eighteen machines of the new type were placed in service numbered 14301 – 14318. They were capable of hauling 520 tonnes at the drawbar, at a speed of 30 km/h over the severest Gotthard gradients and at 35 km/h on a 10‰ gradient. The powerful motors and transformers made possible an increase in maximum speed from 65 km/h to 75 km/h although this decision had to be reversed in later years.

Modified Connecting Rod Arrangement

By this time the prototypes mentioned in Note 1 below had been extensively tested. As described above, Ce6/8I No. 14201 had a different coupling rod arrangement, developed at Winterthur, to that used on the Ce6/8II. On 14201, a normally shaped (and longer) coupling rod transferred the drive from the

Ce 6/8II No 14263 at the head of a goods train in Bern on 7th January 1934.

layshaft to a triangular coupling rod connecting the first and second driving axles, from which the third axle was driven via a further coupling rod.

This was a less complex arrangement that had proven itself with the prototype Ce 6/6 No. 121 of the BLS and also with the Ge 6/6^{I} for the Rhätische Bahn. It did however produce unwelcome swaying on poor track, something that limited its application to locomotives that would not exceed 75 km/h, but that of course would not be a problem for the Crocodile. The arrangement used on the prototype was therefore adopted for the Ce6/8^{III}, with the difference that the whole drive unit was turned around at each end of the locomotive.

Into Service on the Gotthard

From the outset the Ce 6/8^{III} carried a chocolate brown livery with black underframes. Later they appeared in SBB standard pine green with grey underparts. Originally they were intended for service on flatter sections but by 1930 all were working from Erstfeld depot where they replaced many of the first series which were transferred to Basel, Zürich, Lausanne and Romanshorn by 1928.

Prototype Ce 6/8^{I} 14201 is seen here leaving Pratteln with a goods train for Olten circa 1938.

Notes:

(Note 1) The prototypes were a Be 3/5 No. 12202 designed for light passenger work, two heavy mountain locomotives of type Be 4/6 Nos. 12301 and 12302, also for passenger work and Ce 6/8 No. 12201 mentioned in the main text above. 12201 was later renumbered 14201 and the classificatio altered to Ce6/8^{I}. It also acquired the nicknames "Köfferlilok" (Luggage loco) and "Schlotterbeck" (meaning unclear, but believed to be an uncomplimentary reference to vibrations or swaying).

Part Two will appear in a future edition of *Swiss Express.*

More photos from
BERNINA MONSTER IN THE SNOW
on page 13.

ABOVE: The run past "somewhere" near Lago Bianco with Xrot 9213 + Ge4/4 182.
RIGHT: Xrot 9213 at Surovas station.
INSET: ABe4 30 + 34 inside Pontresina depot.