Historic

Locomotive Ce 6/8 II “Crocodile”

Table of contents

Cover photo: Ce 6/8 II 14253 pulling the vintage San Gottardo train over the Kellerbach Bridge

Introduction: A crocodile in the Swiss Alps

In November 1913, the governing board of the Swiss Federal Railways (Schweizerische Bundesbahnen, or SBB) decided to begin electrification of its rail network with the Gotthard line. In 1918, with the required hydroelectric plants almost completed, SBB ordered ten Ce 6/8 II electric locomotives to serve this particularly difficult stretch of its operative grid. These locomotives were later nicknamed “Crocodile”, while, at the same time, the design was widely imitated. After receiving the first deliveries in 1919, SBB put in a follow-up order for twenty-three units to be delivered in 1921 and 1922. The “Crocodile’s” electric motors relied on a single-phase AC system with a frequency of 16 2/3Hz. Already in use on electrified rail lines in Germany, this would become the electrical standard for the Swiss Federal Railways. It remains the railway standard in many countries to this day. Moreover, because SBB used hydroelectricity to power the “Crocodile”, the Ce 6/8 II soon became the most recognizable and visible component of the first major railway line fully operating on renewable energy.

The Ce 6/8 II‘s design was innovative in several respects:

- It integrated mechanical and electrical elements to power a locomotive with a large cargo capacity capable of negotiating tight bends on steep inclines close to the limit of wheel-rail friction.
- The locomotives were primarily designed to serve the Gotthard line, the key north-south rail link bridging the Alps in Switzerland.
- It was the first large-scale application of a single-phase AC system on a main trans-European connection.
- It regenerated dynamic break energy (traction motors that generated power instead of absorbing it) into overhead catenaries, the first successful application of this technology in a single-phase AC system.
- The articulated configuration secured maximum traction.

The most remarkable feature of the Ce 6/8 II was its appearance. It had two low-profile bogies in the shape of snouts facing in opposite directions, each equipped with three powered axles and one non-powered leading axle for guidance. The bogies were hinged directly together and carried a central body that housed the main transformer and duplicated, bidirectional control cabs. This articulated design was a major improvement on an earlier design developed by the Allgemeine Elektricitäts-Gesellschaft (AEG) in 1914. It was later also used by other locomotive designers operating on the same and other gauges. Its appearance distinguished the "Crocodile" from all other locomotives ordered in 1918, such as the Be 4/6 and the Be 4/7. Over the years, the "Crocodile" also became a favourite of railway modellers, drawing more attention than most other locomotives in history.

Figure 1: Ce 6/8 II 14253 on the Gotthard route, undated

The Gotthard and the need for a connection to the south

Switzerland “sits on the Alps” in central Europe, so to speak, and the Gotthard Pass represents the most frequented connection between the north and the south. The high range marks the border between German and Italian-language speaking areas. Despite or precisely because of this, the Gotthard Pass has over the centuries played a pivotal role in establishing Swiss identity.

The first railway line to cross the Gotthard was opened in 1882, featuring a 15 km long tunnel as its centrepiece (Fig. 2). Alfred Escher, a politician and entrepreneur, advanced this project based on a treaty between Switzerland, Germany, and Italy. The procurement of international capital involved the establishment of the Schweizerische Kreditanstalt (SKA), today’s Credit Suisse, still the second largest bank in Switzerland. Escher’s life was not free of conflict, and, unfortunately, he died the year the Gotthard railway was completed.

The slopes leading up to the Gotthard railway tunnel rose 711 metres in the north and 921 metres in the south. The railbed had been designed for steam locomotives, with a maximum gradient of 2.6 %. Moreover, we can only guess the issues health inspectors encountered, considering the smoky conditions in the 15 km long tunnel, the world’s longest at that time. It certainly made one thing clear: operating in long tunnels with steam locomotives had no future.

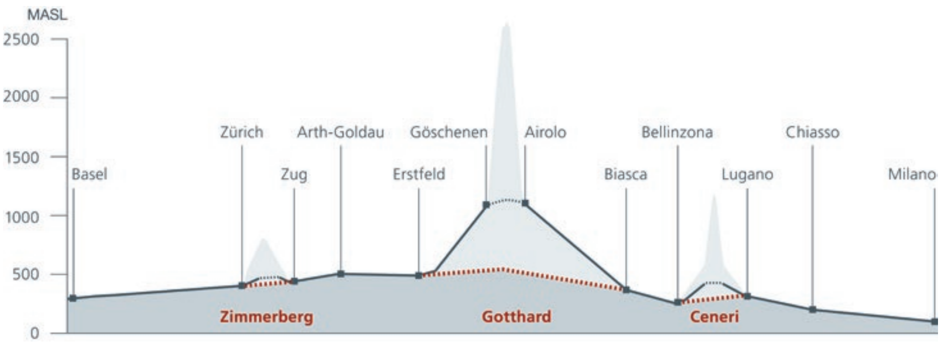


Figure 2: Longitudinal profiles of Gotthard and Ceneri base tunnels. In black: the Gotthard inclines as built in 1882. In red: new tunnels, core section opened in 2016. The mountains above the tunnels are vertically exaggerated.

Early railway electrification in Switzerland

SBB was formed through a merger of five private Swiss railway companies in 1902, based on a federal vote in 1898 to nationalize rail transport. In 1906, SBB opened its first operational electric line in the twin Simplon tunnels, which were 19,803 m and 19,823 m long, respectively, the world's longest at that time. The Simplon line relied on a three-phase AC system with two overhead contact lines (Fig. 3). This was a heritage from the Italian company Rete Adriatica, which, in 1902, used this system for the world's first mainline electric railway in Valtellina.

The late decision for the electric system in the Simplon tunnel led to constraints. Thus, operations started with locomotives rented from Rete Adriatica. Brown, Boveri & Company (BBC), a leading Swiss heavy equipment manufacturing company, also promoted the three-phase system and, together with the Schweizerische Lokomotiv- und Maschinenfabrik (SLM), delivered seven additional locomotives to the Simplon three-phase operation by 1915.

In 1906 the Swiss engineering company Maschinenfabrik Oerlikon (MFO) tested a single-phase AC system at 50 Hz, using an on-board rotary converter; however, this was abandoned again due to electromagnetic interference with phone lines along the test track. A second attempt with 15 Hz allowed the direct use of a series motor thanks to the lower frequency, and this proved to be a success.

A third electric locomotive design from the German company Siemens was tested on the same test track. The frequency was later changed from 15 Hz to 16 2/3 Hz, equalling exactly a third of the standard European grid frequency (nowadays exactly 16.7 Hz). Electric locomotive testing on the Seebach-Wettingen track under the direction of MFO continued until 1909 [1].

However, SBB did not buy the equipment in spite of its technical success, and the test track returned to steam-driven operation. Still, MFO delivered single-phase electric locomotives to other railroads, among them the motor coach BCFe 4/4, which used 5000 V at 20 Hz, to the Valle Maggia Railway in Switzerland in 1907, and an F 2x3/3 to the Bern–Lötschberg–Simplon Railway Company (BLS). They tested this unit for single-phase AC at 15000 V and 15 Hz on the northern slopes of the BLS-operated second trans-Alpine railway in Switzerland.

The two decades preceding the introduction of the “Crocodile” were characterized by many parallel attempts to introduce electric traction systems on railways in Europe, USA, Canada, and Japan. Wyssling reports on the intense disputes in Europe concerning the choice of the the right electric system [7]. In 1910, an international railway conference in Berne erupted in heated arguments between groups promoting DC systems, three-phase AC systems, and single-phase AC systems. A conference of German-speaking railway operators in 1913 selected a single-phase AC system operating at 16 2/3 Hz (1/3 of the 50 Hz frequency common on the European grid). This choice has endured until today with regard to electrified lines in German-speaking countries as well as in Norway and Sweden, which together represent around a third of the European total (the rest use 50 Hz).

In 1913 the SBB were still testing. But they had begun to construct the hydropower plants required for the electrification of the Gotthard line even before making a final decision regarding the appropriate electric system. At the same time, the independent Swiss companies BLS and Rhaetian Railway (RhB) were already introducing single phase AC systems acquired from MFO and BBC, respectively. The First World War (1914 – 1918) caused a coal shortage in Switzerland and accelerated electrification because Switzerland had abundant hydropower opportunities.

This formed the background of the SBB order that was finally placed in 1918. SBB’s decision to waive testing a prototype (usually a standard procedure) underlines the urgency the company felt to electrify its operations. SBB was lucky: the ten delivered Ce 6/8 II “Crocodiles” proved highly reliable, and SBB quickly went on to order an additional twenty-three units to be delivered in 1921 and 1922. One reason for the new locomotive’s exceptional performance was the experience the manufacturers MFO and SLM already had with most of the components used, even though the design and system integration were new. For SBB, the “Crocodile” opened up a new age of rail transportation.

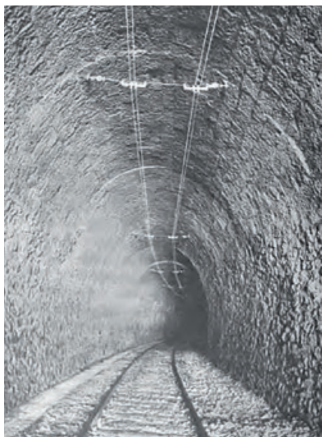


Figure 3: The historic three-phase over-head contact line in the Simplon tunnel.

Ce 6/8 II: Birth of a legend

The "Crocodile" was a response to the competition briefly described here: The Swiss company BBC initially preferred three-phase technology. But in 1913, BBC delivered its first electric locomotive to the Rhaetian Railway (meter gauge) that was designed to operate using single-phase AC. It operated at 11000 V and 16 2/3 Hz, generating 300 HP (pictured in [6]). For this order, BBC used Deri (repulsion) motors with turnable brush bridges for control. But due to poor efficiency this technology was soon abandoned.

In 1917 BBC, like MFO, sold a fleet of locomotives and two prototypes to SBB (see table below). One of the BBC prototypes competed with the "Crocodile". This was the SBB type Fc 2x3/4 (synonymous with Ce 6/8 I), SBB serial number 14201. It is reported that it was delivered a week after the first "Crocodile", with a different appearance and without the electric brake required by specification, apparently due to weight considerations [8].

Figure 4: Ce 6/8 II in the railway workshop in Bellinzona, undated

BBC's answer to MFO's electric regenerative brakes was eventually installed in 1920. This was a solution based on an on-board rotary converter, which was heavier than MFO's system relying on a reactance coil. In a publication at the time, Theodor Boveri indicated the adoption of this technology [6]. It turned out to be very efficient, but was complicated to handle. It was able to hold the

Designing Companies	Type and SBB unit numbers	Year of order / intended use	Drive system
BBC/SLM	Be 4/6 12302, initially Fb 2x2/3 11302, Ce 4/6 114201, initially Fc 2x3/4 112201 Be 4/6 12303 – 12342	1917 / Prototype 1917 / Prototype As of July 1918 / 40 Units, express train	rod rod rod
MFO/SLM	Be 3/5 12201, initially Fb 3 / 5 11201, Be 4/6 12301, initially Fb 2x2 / 3 11301 Ce 6/8 II 14251–14283 ("Crocodile")	1917 / Prototype 1917 / Prototype As of May 1918 / 33 units, cargo train	rod rod rod
SAAS/SLM	Be 4/7 12501–12506	July 1918 / 6 units, express train	single

downhill speed of a 300-ton train constant. However, the BBC system suffered from occasional high voltage sparkovers and, on one occasion, the main switch even exploded. The regenerative braking equipment was removed from this locomotive in 1931, but it had confirmed the potential of regenerative technology. This unit remained in service until 1982 and today features as an historic SBB railway pioneer artefact at the Museum of Transport in Lucerne.

Reports from private sources indicate that BBC, MFO, and SAAS (Société Anonyme des Ateliers de Sécheron) cooperated in standardizing the trains' bodies even while technical competition between them remained intense and generated different technological solutions. As Schneeberger [8] discovered, SBB's order lists reflect the intention of striking a balance between Swiss locomotive suppliers located in different parts of the country. This is borne out by the distribution of SBB orders between the two large companies (BBC and MFO) and the smaller SAAS: All the locomotives from the three fleets remained in service for forty or more years. SAAS's Be 4/7 was loved by train drivers because of its smooth operation thanks to its Westinghouse-licensed single-axle drive.

It seems that MFO (Maschinenfabrik Oerlikon) played a leading role in the development of the Ce 6/8 II, based on their experience [1] and on their patents [2]. The mechanical parts supplied by the Schweizerische Lokomotiv- und Maschinenfabrik (SLM) were selected on the strength of the company's experience with existing components already in wide service. The principal mechanical designer can no longer be identified with certainty. We can only assume that it was Hans Behn-Eschenburg (Fig. 5) who suggested the engine's external shape with the two long snouts and the driver's cab overlooking them. This assumption is based on his publication [3]. Some of MFO's publications fail to identify the author. But we may assume that articles [4] and [5] were written by him or at least under his supervision. The nickname "Crocodile" first appeared in Märklin's model railway catalogue of 1933/34. It stuck and later spread across the entire globe.

The "Crocodile" concept with its unique appearance represented a combination of the best available technologies for hauling heavy cargo on the Gotthard line at the time SBB placed its order in 1918. The basic mechanical layout utilized two bogies (wheel trucks) directly connected with a bar on two hinges. The bogies carried a central cab on two support hinges; it contained the heavy transformer, the main and step switches, and the driver's control panels for both directions.

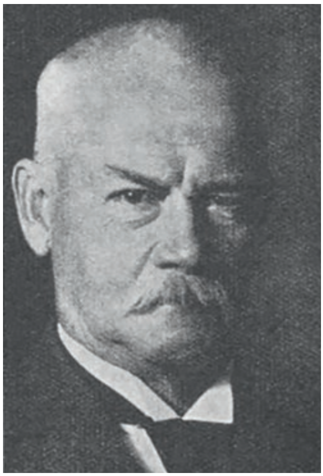


Figure 5: Hans Behn-Eschenburg, The key figure responsible for the electric technology and later CEO of MFO

One of the support hinges was fixed longitudinally movable in order to avoid a statically indeterminate condition. The purpose of this arrangement was to transmit the buffer load not via the central body but directly between the bogies. It was the concept that allowed the shortest possible length within the spec. A similar alignment had first been used by AEG in 1914 on the locomotive EG 511. The EG 511 had two bogies with two axles and a transformer with externally mounted coolers.

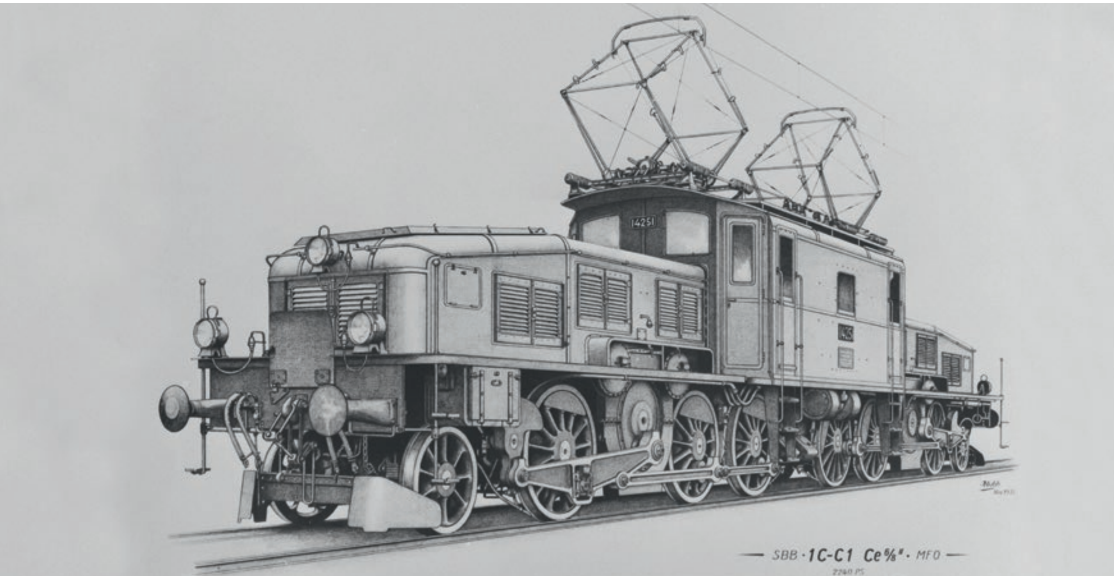


Figure 6: Drawing of the Ce 6/8 II, 1935

Ce 6/8 II “Crocodile”: Specifications

Weight: 126 tons
Adhesion Weight: 103 tons
Power, max. speed: Continuous 1340 kW at 65 km/h
Electrical Power supply: 15 kV, 16 2/3 Hz. Initially operated at 7,500 V because of the mixed operation with steam locomotives, which soiled the insulators with soot. An electric brake was required.
Pulled Train weight: 430 tons at 35 km/h and 2,8 % gradient
Pull force at start: 30 tons

Mechanical concept

Each bogie contains two electric motors driving a blind (or jack) shaft via geared wheels. The jack shaft powers the three drive axles via connecting rods (Fig. 7). MFO was responsible for the electric parts, SLM for the mechanical parts.

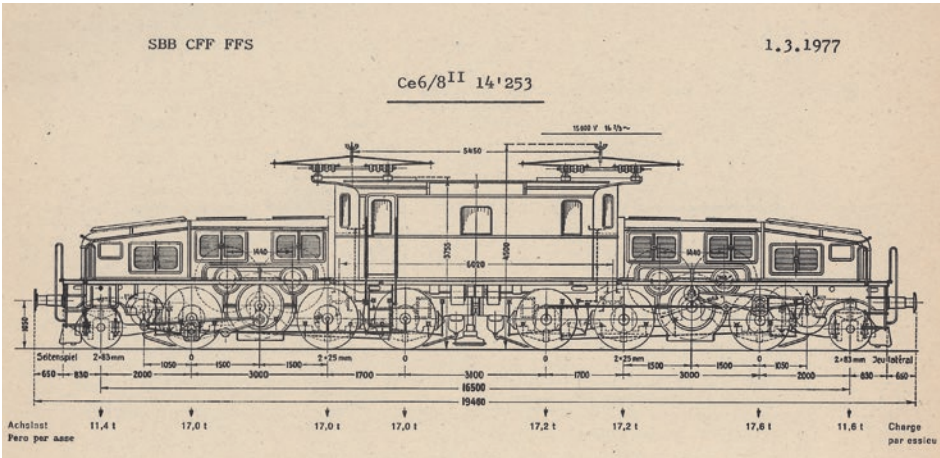


Figure 7: Sketch of the Ce 6/8 II with the main dimensions

The use of the rod drive to connect the three powered axles was based on state-of-the-art technology at that time. Although single-axle drives were already in use then, two reasons probably influenced the decision:

- The designers believed that three linked axles would reduce the risk of sliding.
- MFO, at the time, preferred larger (and fewer) electric motors per vehicle.

As an additional precaution to reduce wheel slip, the “Crocodile” was equipped with two electrical load (ampere) meters and a window in the lateral platform providing the engine driver with a view of the drive rods. The locomotive was also equipped with a device to spread sand on the railheads in front of the drive wheels. Later, SBB switched to single-axle drives for passenger trains, starting with the Ae 3/6 II series.

Pneumatic systems

The engine driver's controls were primarily pneumatic. Pneumatic systems lifted the pantograph and activated the horn, the main switch and the direction selector (also allowing electric brake selection). One of the two wipers on the Ce 6/8 II 14253 was pneumatic, but we do not know whether this was initially the case. The other wiper could be moved by hand.

Brake systems

SBB's locomotive specifications of 3 May 1918 requested an automatic pneumatic brake, a hand-operated Westinghouse brake for the whole train, and an electric brake with either regeneration or braking resistors. The latter was to have sufficient power to maintain control of the locomotive specifically on the Gotthard's downhill slopes, but preferably also to keep the whole train at a constant speed. The "Crocodile's" designers decided for regeneration over braking resistors. The electrical brake was initially only used for emergencies.

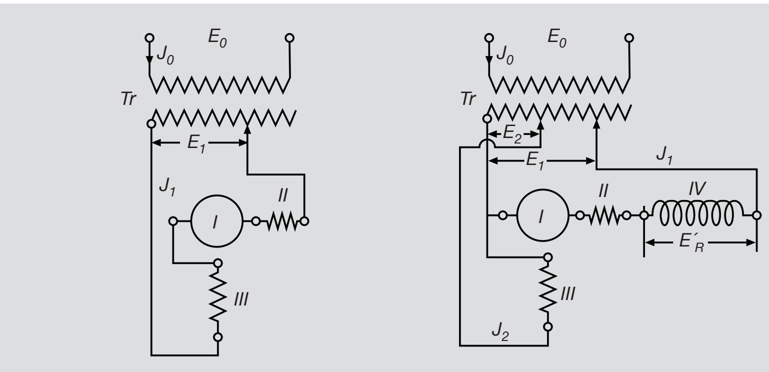


Figure 8: Electric scheme of the motors for driving and for electric braking, copied from [3]

Indeed, it was only sufficient for the locomotive alone. But the driver's directory of 1926 indicates that regenerative breaking was already being used on normal runs when moving forward, thus providing current to the grid. It was not usable for backward driving. The design of the regenerative brake was patented by MFO [2] (Fig. 8).

Each driver's cab had a crank-operated hand brake. The Ce 6/8 II 14253 also has a "dead-man's pedal", on which the driver's foot had to rest with only very short interruptions allowed; otherwise the driver faced the risk of a forced braking.

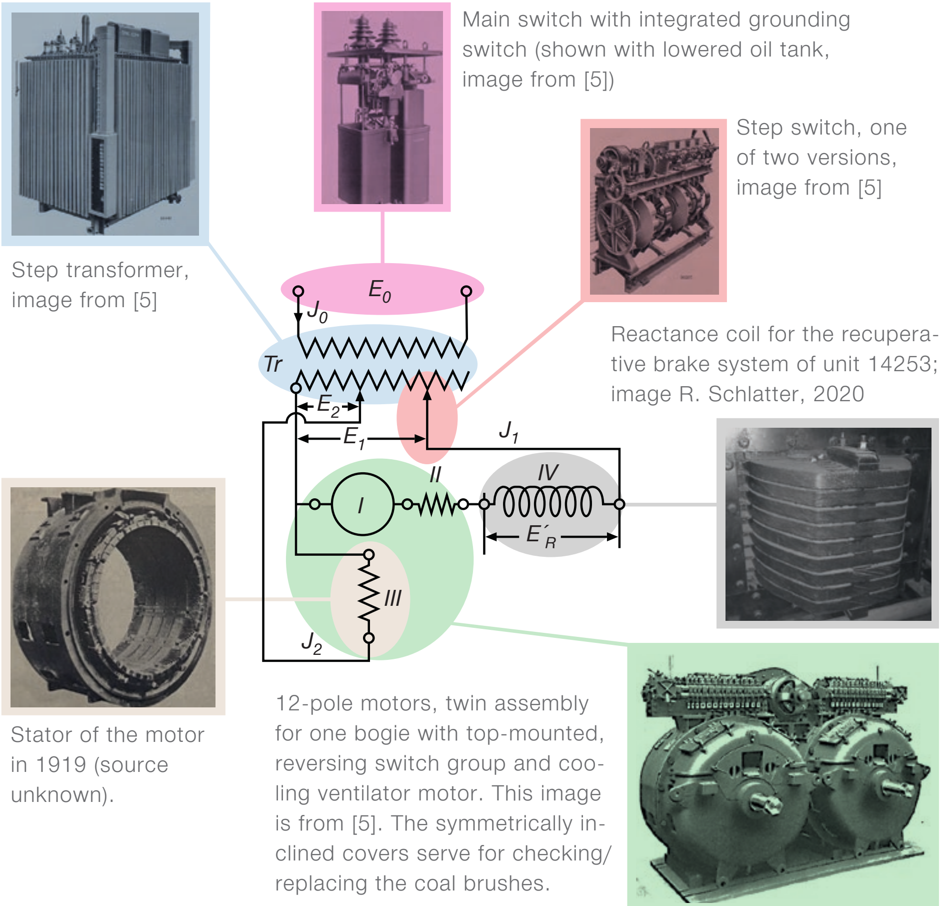
The regenerative brakes

Due to the efforts noted above, MFO had a technical advantage with regard to single-phase AC systems over its main competitor BBC. A detailed article published in 1919 described the electric scheme and tests with a 2250 HP locomotive (type Be 4/6 number 11301, later changed to 12301) [3]. This locomotive did not yet have the appearance of a "Crocodile". The tests carried out with this locomotive included the first regenerative brake system for this kind of electric system.

We may assume that this technology was included in the first two "Crocodiles" delivered that same year. The article [3] mentions an interesting functional feature of the electric brake system. Other than in series engine operation, the power of the electric brakes does not depend on the speed but only on the step switch position. In the case of the Ce 6/8 II, this switch has twenty-two positions. When the driver maintained a constant downhill speed, this resulted in a saw tooth-shaped speed pattern due to the periodic intervention of the train's friction brakes.

The author had the opportunity to look at train driver's instructions for the "Crocodile" issued in the years 1920, 1926, and 1950. In 1920, the regenerative brakes were to be used for emergencies only, while in 1926 and 1950 they were also used in normal operations as a way to save wear on the friction brakes. The energy-saving aspect was not mentioned in any of these documents. However, the instructions note that the brake's effect depended on effective contact between the pantograph and the trolley system, in contrast to other locomotives using onboard resistors for the electric brakes. Losing contact with the overhead catenary required the immediate switch-down of the electric brake controller.

The figure 9 explains with contemporary pictures how the Maschinenfabrik Oerlikon has materialized the (simplified) electric scheme of figure 8 into real components in 1919/1920. Remarkably, the “Crocodile’s” recuperative brake system is still the same as at the time of its invention.



Step transformer, image from [5]

Main switch with integrated grounding switch (shown with lowered oil tank, image from [5])

Step switch, one of two versions, image from [5]

Reactance coil for the recuperative brake system of unit 14253; image R. Schlatter, 2020

Stator of the motor in 1919 (source unknown).

12-pole motors, twin assembly for one bogie with top-mounted, reversing switch group and cooling ventilator motor. This image is from [5]. The symmetrically inclined covers serve for checking/replacing the coal brushes.

Figure 9: Ce 6/8 II components referring to the (simplified) electric scheme for electric recuperation, see [3]. The complete contemporary electric schemes are included in the publications [4] and [5].

Technological significance

The technological, commercial, and operational success of the Ce 6/8 II technology is borne out by the following facts:

1. The long service life of the ten-unit fleet. The original ten “Crocodile” locomotives entered into service in 1919/20 and were only phased out between 1968 and 1982.
2. SBB put in a follow-up order for another twenty-three units a year later.
3. Each “Crocodile” locomotive covered around four million kilometres during its time in service [8].
4. Series drive electric motors, like those on the “Crocodile”, remained technologically dominant until the 1970s.
5. In service, the “Crocodiles” were relatively easy to maintain and, as they proved reliable and durable, SBB increased their maximum operative speed from 65 to 75 km/h, as Schneeberger explains in his book [8].
6. The “Crocodiles” were later successfully repurposed as shunting or switching locomotives.
7. The first of the surviving nine units, held and maintained by various historic preservation societies, are now a hundred years old.

For the first time, the technology of the electric series motor was rolled out with the “Crocodile” on a large scale, and dominated electric traction until the 1970s. Since then the technology has gradually lost importance due to newer, technically superior power electronics. This new technology allows the use of single-line trolley systems operating at any frequency and voltage. It converts the overhead catenary current into an intermediate DC (known as DC link or DC bus) and from this into a synthetic three-phase AC power to control the traction motor's rotation speed. This has led to a revival of the simpler, asynchronous motors for traction drive, today the dominant system. The moment characteristic of the drive is therefore determined no longer by the motor but by the electronics. The 16 2/3 Hz AC used on many railways still requires an extra grid compared to 50 Hz lines. But modification of 16 2/3 Hz lines to 50 Hz has not yet been considered as it would also mean replacing numerous ancillary systems and because modern electronics allow switching between different electrical supply systems.

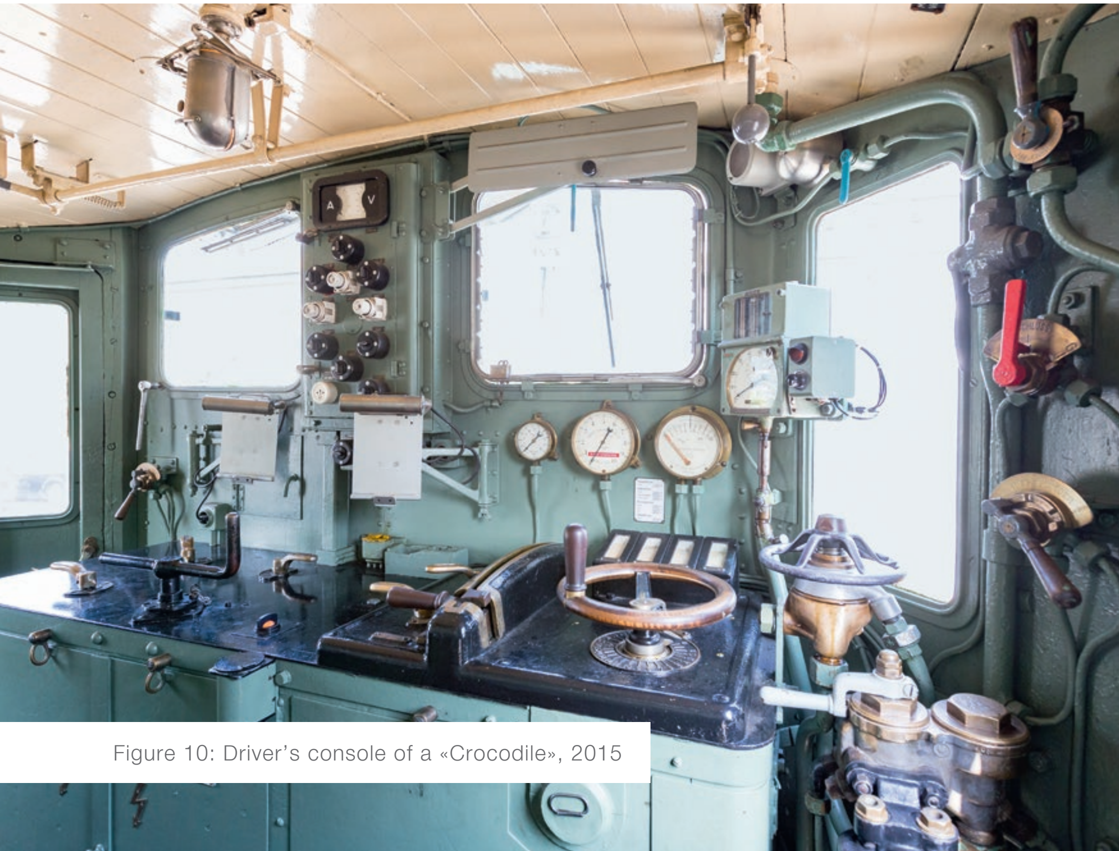


Figure 10: Driver's console of a «Crocodile», 2015

Incidents

The most serious accident involving a Ce 6/8 II occurred in 1948. A passenger train carrying alpine skiers pulled by “Crocodile” 14269 was descending down a 5 % gradient above Wädenswil station. The driver mistook the position of the electric switch regulating the driving and braking power, thinking that it was in the brake position when it was actually in the drive forward mode. When the driver shifted the step switch upwards, he inadvertently increased the traction power instead of the electric regenerative brakes. In spite of using all the other (friction) brakes, the train accelerated downhill in excess of the 35km/h speed limit. The staff at Wädenswil station was warned of the impending danger and diverted the train – then travelling at around 60 km/h – into a dead-end side track. Still, the crash that followed destroyed half a building and killed twenty-two people. The driver survived the accident thanks to the “Crocodile’s” long snout. Astonishingly, the crashed Ce 6/8 II was repaired and remained in service until July 1981.

Figure 11: Damaged Ce 6/8 II 14269 in the railway workshop in Zürich, 1948

The "Crocodile's" legacy

The Ce 6/8 II and Ce 6/8 III, respectively, pulled freight trains over the Gotthard until the mid-1960s. Some were reassigned to lines with gentler inclines in other parts of Switzerland. On the Gotthard line, they were gradually replaced by stronger and more modern locomotives such as the Ae 4/7 and the Ae 6/6. The "Crocodile" fleet was subsequently decommissioned and phased out of SBB operations between 1965 and 1982, after sixty-three years of service. During this time, the "Crocodiles" attracted more attention than any other contemporary locomotive due to their unique appearance. They were the favourite of train spotters and model railway makers. Similar designs were constructed for foreign railways as well as other Swiss rail companies. Meanwhile, the meter-gauge Rhaetian "Crocodile" and the Bernina "Crocodile" (both owned by RhB) have also attained historic status.

Figure 12: Ce 6/8 III 14305 in Olten, 2015

The railway lines served by the “Crocodile” were extremely important for Switzerland during the Second World War as the country was facing foreign supply shortages and the threat of occupation. By that time the rail network was mostly electrified. The railway lines over the Alps played an important part in maintaining Swiss independence since Italy was dependent on German supplies that had to be shipped across the Alps. Since it was easy to disrupt, the Gotthard connection served as an insurance against any attack by the Axis powers. The development of the Swiss rail power grid was a pivotal technical achievement, with the “Crocodile” being its most visible component. It showed that a new technology could be established and commercialized on a large scale within a matter of ten years, in a way maybe similar to the development of electric cars today. Electrification made the job of the stoker on steam trains almost obsolete within ten years. However, the men were not fired but continued to work as co-drivers. In French-speaking regions, the stoker’s old professional designation “chauffeur” even evolved to mean driver in general. This term is now also used in German.

Last but not least, the publication of books dealing with the subject, like those by Zellweger [9 and 10], underline the lasting public legacy of the “Crocodile” locomotives.

Surviving types

The following table lists all the classic SBB “Crocodiles” surviving to date. During their service life, some of these units operated with modifications and temporarily changed type designations (Be instead of Ce, indicating the increase of the allowed speed from 65 to 75km/h). The Ce 6/8 III version appears very similar, with exception of the drive rod arrangement which looks visibly different.

Serial Number	New in	Original Type	Owner	Remarks and locations
14253	1920	Ce 6/8 II	SBB Historic	Serviceable, nominated for the Landmarks Program, located in Erstfeld.
14254	1920	Ce 6/8 II	SBB Historic	Verkehrshaus, as of 1944 Be 6/8 II, inventory number VHS-8700; on exhibit in hall “Train Traffic 1”.
14257	1920	Ce 6/8 II	In Austria	Südbahnmuseum Mürzzuschlag (now as 13257, Be 6/8 II)
14267	1921	Ce 6/8 II	In Germany	Since 1991 in Technikmuseum Speyer, Germany
14270	1921	Ce 6/8 II	SBB Historic	Memorial, not serviceable but nicely restored, moved to Oerlikon, the place of its original assembly on 15 June 2020.
14276	1922	Ce 6/8 II	Club San Gottardo	Mendrisio, Switzerland
14282	1922	Ce 6/8 II	In Germany	Auto- und Technikmuseum Sinsheim, Germany
13302	1926	Ce 6/8 III modified: Be 6/8 III	SBB Historic	Serviceable. Maintained by a team called “Betriebsgruppe 13302” based in Horgen. Now located in Rapperswil, Switzerland
13305	1926	Ce 6/8 III Renamed into 14305	SBB Historic	Serviceable. This unit drove to Gävle (Sweden) in 2015 pulling an extra train, partly with its own power, for the celebration 100 years of electric trains in Sweden. The electric systems on this journey of 1,600 km were compliant. Now located in Olten.

Ce 6/8 II “14253”: A Historic Mechanical Engineering Landmark

The locomotive nominated by the American Society of Mechanical Engineers (ASME) for the Landmarks Program was originally delivered to the SBB in the spring of 1920 and was given the serial number 14253. It was the third vehicle of the Ce 6/8 II type to leave the factory hall. Since the Gotthard line was then not yet fully electrified, the first generation of “Crocodiles” operated on the Bern-Spiez line, including the train with the number 14253. In 1921, it finally entered service as a freight engine on the Gotthard line but was transferred from its depot in Erstfeld to Basel as early as 1924 and from there to Zurich in 1926. It only returned to Erstfeld during the Second World War when the vast bulk of “Crocodiles” was used to carry heavy freight over the Gotthard. In 1947, the engine was upgraded to a Be 6/8 II and received a new serial number, 13253. Due to its enhanced engine power, vehicle 13253 was now not only suitable as a freight locomotive but also as an engine for the somewhat faster passenger trains.
After its discharge from mainline service in 1976, vehicle 13253 became the first “Crocodile” to be registered as a historical locomotive. After a major overhaul in the same year, the engine was reassigned its original serial number and is now back in operation on nostalgia rides under the designation Ce 6/8 II 14253. The vehicle is now the oldest “Crocodile” still in operation after covering more than six million kilometres to date.

It is owned by SBB Historic – a public trust with the mission of upholding the memory of the Swiss railways’ historic achievements. Its main task is to keep important historical vehicles accessible to the public and to maintain them in a serviceable state as best as possible. This is quite an arduous task; protecting them from the weather and the corrosion that comes with it is probably the easiest part.

The Ce 6/8 II 14253 is kept under roof in Erstfeld, Switzerland, together with other historic vehicles. Perhaps the hardest part is maintaining the hydrodynamic bearings. Typically, hydrodynamic bearings under load suffer if left stationary for long periods. To avoid this, SBB Historic organizes occasional public rides on vintage trains. But these public rides are not frequent enough to maintain the units in a serviceable state. Therefore, SBB Historic has introduced so-called “fitness rides” on a monthly basis. On these occasions, historic locomotives are driven back and forth on station tracks visible to the public. These events have become increasingly popular and attract train enthusiasts from near and far, especially in the summer months.

A locally based society of volunteers carries out the preparations for these fitness rides and provides the train drivers, who must hold a valid permit for driving on SBB train lines with cargo and passenger trains. The preparation of the locomotive for the monthly fitness ride includes checking more than 150 lube points with different grease-and-oil dosage systems, some wick-based, some movement controlled. Volunteers also clean and check all pressurized air valve positions and the carbon brushes of the motor collectors. SBB Historic also provides spare parts, which is challenging because the original suppliers of parts for the «Crocodile» no longer exist. Consequently, preparations take hours. Only after this work is done, can the driver take up his work at the driver’s console (Fig. 10). After the ride, preparations for the next intermediate period start immediately.

Figure 13: Ce 6/8 II 14253 pulling the vintage San Gottardo train on the Gotthard route, 2021

The Plaque

Historic Mechanical Engineering Landmark
Ce 6/8 II «Crocodile»

1920

In 1918, Swiss Federal Railways ordered ten locomotives for heavy freight traffic on the newly electrified Gotthard line. The locomotive they chose was the Ce 6/8 II (nicknamed "Crocodile"). The innovative combination of articulation, regenerative braking, single-phase, series motors, and other elements produced a reliable locomotive capable of handling the Gotthard's tight bends and steep slopes. Many aspects of the "Crocodile's" design were imitated by other electrified railways, and its unique appearance made it famous throughout the world.

The locomotive with the serial number 14253, delivered in 1920, was the third Ce 6/8 II to be produced. It is the oldest existing locomotive of its kind and still operational today.

American Society of Mechanical Engineers

Appendix: Relevant dates

The backdrop to the construction of the "Crocodile" locomotives was the electrification of the transalpine railway line via the Gotthard route.

1913: On 15 November, the governing board of SBB takes the decision to electrify the Gotthard line between Erstfeld and Bellinzona and authorizes 38.5 million Swiss francs for the purpose.

1916: On 16 February, SBB decides to electrify several of the tracks feeding into the two lines across the Swiss Alps and selects single-phase AC for power supply.

1918: In June SBB orders the first ten locomotives of the type Ce 6/8 II from SLM (mechanical parts) and MFO (electrical parts).

1919: The first two Ce 6/8 II are delivered (14251 and 14252, both have now been scrapped).

1920: The next eight units are delivered (14253 through 14260). The locomotive with the serial number 14253 was the third to be produced and is now the oldest existing unit.

1921: Further thirteen units are delivered (14261 through 14273).

1922: The last ten Ce 6/8 II are delivered (14274 through 14283).

1925: The Ce 6/8 III, a new "Crocodile" generation, is launched on the market. SBB orders a further eighteen locomotives of this type.

From 1943: SBB has thirteen Ce 6/8 II locomotives of its fleet modernized by SLM in Winterthur. After refurbishment they are referred to as Be 6/8 II and given new serial numbers. Their motors have 60% more power and allow speeds of up to 75 km/h.

1956: The Ce 6/8 III receives approval for a maximum speed of 75 km/h. All eighteen locomotives are given the new designation Be 6/8 and new serial numbers.

From 1964: The majority of now ageing Be 6/8 II is transferred to Zurich where they are used to haul heavy gravel trains. From 1970, several Be 6/8 IIIs supplement the "gravel train fleet".

From 1965: Twelve of the remaining Ce 6/8 IIs are converted into shunters.

1971: The last of the Ce 6/8 II still serving on the main line is decommissioned.

1976: Ce 6/8 II 14253 is the first “Crocodile” of its generation to begin a new chapter in life as a historic locomotive; since then it has been used for nostalgia rides.

1977: The last Be 6/8 III is taken out of service.

1986: The last Ce 6/8 II being used as shunter is decommissioned.

2022: Ce 6/8 II 14253 is declared a Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers (ASME).

Figure 14: Shunting yard Muttenz, ca 1940

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Abbreviations

AEG Allgemeine Elektricitäts-Gesellschaft (Berlin), operative 1893–1996
BBC Brown Boveri & Co (Baden, Switzerland), operative 1891–1987
BLS Bern Lötschberg Simplon (-Bahn), railroad independent of SBB
MFO Maschinenfabrik Oerlikon (Zurich, Switzerland), operative 1876–1967
RhB Rhaetian Railways (railway company independent of SBB)
SBB Schweizerische Bundesbahnen SBB (Swiss Federal Railways), established 1902. French: CFF Chemin de Fer Federale; Italian: FFS Ferrovia Federale Svizzera
SAAS Société Anonyme des Ateliers de Sécheron (Geneva), operative 1882 (1918)–(1982) 1987 (under different names)
SLM Schweizerische Lokomotiv- und Maschinenfabrik (Winterthur), operative 1871–2005

Table of figures

AlpTransit AG, www.alptransit-portal.ch: Fig. 2
André Niederberger: Fig. 13
SBB Historic: Fig. 1, 4, 6, 7, 10, 11, 12, 14
Georg Trüb: Cover photo
Hans Wettstein: Fig. 9
Wikipedia: Fig. 3, 5

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