

Building the line: Favre's contract and the summit tunnel

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The summit tunnel between Göschenen in Uri and Airolo in Ticino was the heart of the project and its greatest risk. The company put the construction of the tunnel out to tender in 1872 and received bids from several contractors. The Geneva engineer and contractor Louis Favre won the contract, which was signed on 7 August 1872. He had prevailed over six competitors with an offer that was 12.5 million francs lower than theirs.¹ Favre's price was 2,830 francs per metre of tunnel. His principal competitor, the Italian Severino Grattoni, who had worked on the Mont Cenis tunnel, had bid 3,389 francs per metre.² The choice of the cheapest bid by a wide margin was understandable for a company whose financing rested on a fixed estimate. It also meant that the risk of underestimated geology was transferred, at least on paper, to a contractor whose balance sheet was far smaller than the risk he assumed.

The contract terms were severe. Favre undertook to complete the tunnel within eight years. For every day by which he finished early he was to receive a bonus of 5,000 francs, and for every day of delay he was to pay a penalty of 5,000 francs, rising to 10,000 francs a day once the delay exceeded six months. He had to deposit security of 8 million francs.³ The tunnel had been estimated at 59.6 million francs within the total budget of 187 million.⁴ In modern terminology Favre's contract was a fixed-price, date-certain turnkey contract with liquidated damages and a performance bond, the kind of agreement that lenders to a modern infrastructure project demand in order to shift completion risk to the contractor. The difference lay in the proportions. Favre's security of 8 million francs and his own capital were small beside the losses that geological surprises could cause, so that the risk transfer was only as good as the contractor's ability to pay.

The works began in the autumn of 1872 from both ends of the tunnel.⁵ Favre used the most advanced techniques of his time, including

compressed-air drilling machines and dynamite, which Alfred Nobel had patented only a few years earlier. The machines were driven by compressed air generated by water power at both portals. The air they released also ventilated the tunnel face, although never sufficiently. The rock proved more varied and more difficult than the geological surveys had predicted. Unstable rock strata, which often changed character every few dozen metres, exerted enormous pressure on the timbering and later on the masonry lining. Constant water intrusions hampered the work, while temperatures at the face rose above 30 degrees Celsius as the headings advanced into the massif.⁶ Each of these problems slowed the advance and raised the cost per metre.

While the tunnel advanced, the company also had to build the approach lines. The lowland lines in Ticino, from Biasca to Bellinzona and Locarno and from Lugano to Chiasso, were completed first and opened on 6 December 1874.⁷ These isolated sections served local traffic but could not generate the transit revenues on which the company's finances depended. The mountain ramps posed the most serious engineering problem outside the summit tunnel. In the Reuss valley north of Göschenen and in the Leventina south of Airolo the line had to climb several hundred metres within a short distance. The chief engineer Robert Gerwig, a Baden railway engineer, planned the ramps in the first years. After cost overruns on the Ticino sections he resigned in 1875. His successor, Wilhelm Konrad Hellweg, and his assistant Eduard Gerlich redesigned the mountain routes with spiral tunnels, which allowed the trains to gain height inside the mountain.⁸ The spirals near Wassen in the Reuss valley and in the Leventina at Rodi-Fiesio and Giornico became the most famous features of the line. They were technically ingenious and financially dangerous, because Hellweg's calculations showed that the original budget had been far too low.

The chronology of the project from 1872 to 1875 thus combined steady progress on the ground with a growing gap between the budget and the cost to complete. The company reported to its shareholders, to the Federal Council and to the subsidy states, but the reports of the early years did not present the full extent of the problem. Part of the difficulty lay in the method of estimation. The estimate of 1869 had been prepared before the detailed design of the ramps and before any experience with the geology of the tunnel had been gathered, so it was little more than a feasibility figure. Another part lay in the incentives of the people involved. Escher and the direction had staked their reputation on the figure of 187 million francs, the subsidy states had fixed their contributions on its basis, and the banks

had placed the securities on the strength of it. Nobody had an interest in announcing early that the figure was wrong.

1 Notes

1. SBB Cargo blog, “Les pionniers du Saint-Gothard (2): Louis Favre”, <https://blog.sbbcargo.com/fr/les-pionniers-du-saint-gothard-2-louis-favre/>. ↩
2. Konrad Kuoni, “Der Gotthardbahnbau: Querelen und Opfer”, NZZ Folio, July 1995, <https://www.nzz.ch/folio/der-gotthardbahnbau-querelen-und-opfer-ld.1616213>. ↩
3. Kuoni, “Der Gotthardbahnbau: Querelen und Opfer” (see above), on the eight-year period, the penalties of 5,000 to 10,000 francs a day and the security of 8 million francs; SBB Cargo blog, “Louis Favre” (see above), on the bonus of 5,000 francs per day ahead of schedule. ↩
4. Kuoni, “Der Gotthardbahnbau: Querelen und Opfer” (see above). ↩
5. Röhl, Enzyklopädie des Eisenbahnwesens, “Gotthardbahn” (see above), on the start of works in autumn 1872. ↩
6. Wikipedia (German), “Gotthardtunnel”, <https://de.wikipedia.org/wiki/Gotthardtunnel>, on the unstable rock strata that changed character every few dozen metres, the constant water inrushes (“ständige Wassereinbrüche”), the breaking of the timber supports under unexpected rock pressure and temperatures of 33 °C and later up to 40 °C. HLS, “Ferrovia del Gottardo” (see above), confirms the use of dynamite. ↩
7. Röhl, Enzyklopädie des Eisenbahnwesens, “Gotthardbahn” (see above); Wikipedia (German), “Gotthardbahn” (see above), which names the sections opened on 6 December 1874. ↩
8. Wikipedia (German), “Gotthardbahn” (see above), on Gerwig’s resignation in 1875 and the redesign by Hellwag and Gerlich with spiral tunnels. ↩

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