construction of large concrete arches have been toward the gradual increase in the main dimensions of such structures as will be noted in the following historical outline. In 1906 the largest arch span was the famous Walnut Lane arch at Philadelphia, Pa., with a clear span of 232 ft. In 1909 the Stein-Teufen arch in Switzerland, with a span of 259 ft., was built. The year 1911 saw two long span arches completed, *viz.*, the Risorgimento arch over the Tiber at Rome, with a clear span of 328 ft. 1 in., and a rise of about 32 ft., and the Auckland, New Zealand, arch, with a clear span of 320 ft. and a rise of 84 ft. The Larimer Avenue arch, Pittsburgh, Pa., with a clear span of 300 ft. 5 in. and a rise of 67 ft., was completed in 1912. The Langwies arch has a clear span of 314 ft. 11½ in., a rise of 134 ft. 3 in., and a crown height above the valley of about 203 ft. Although about 13 ft. shorter than that of the Risorgimento arch and 5 ft. shorter than that of the Auckland arch, the rise exceeds that of the former by about 102 ft. and that of the latter by about 50 ft. The only structure with a rise anywhere near as great as this is the Monroe Street arch at Spokane, Wash., with a span of 281 ft. and a rise of 113 ft. The Langwies arch is designed for a narrow gauge electric railway, while the others are for heavy highway loading only. As far as esthetic design is concerned, the Langwies arch outranks by far the two arches just mentioned, and, although not as artistic as the Larimer Avenue bridge, is an excellent example of a plain but graceful design.

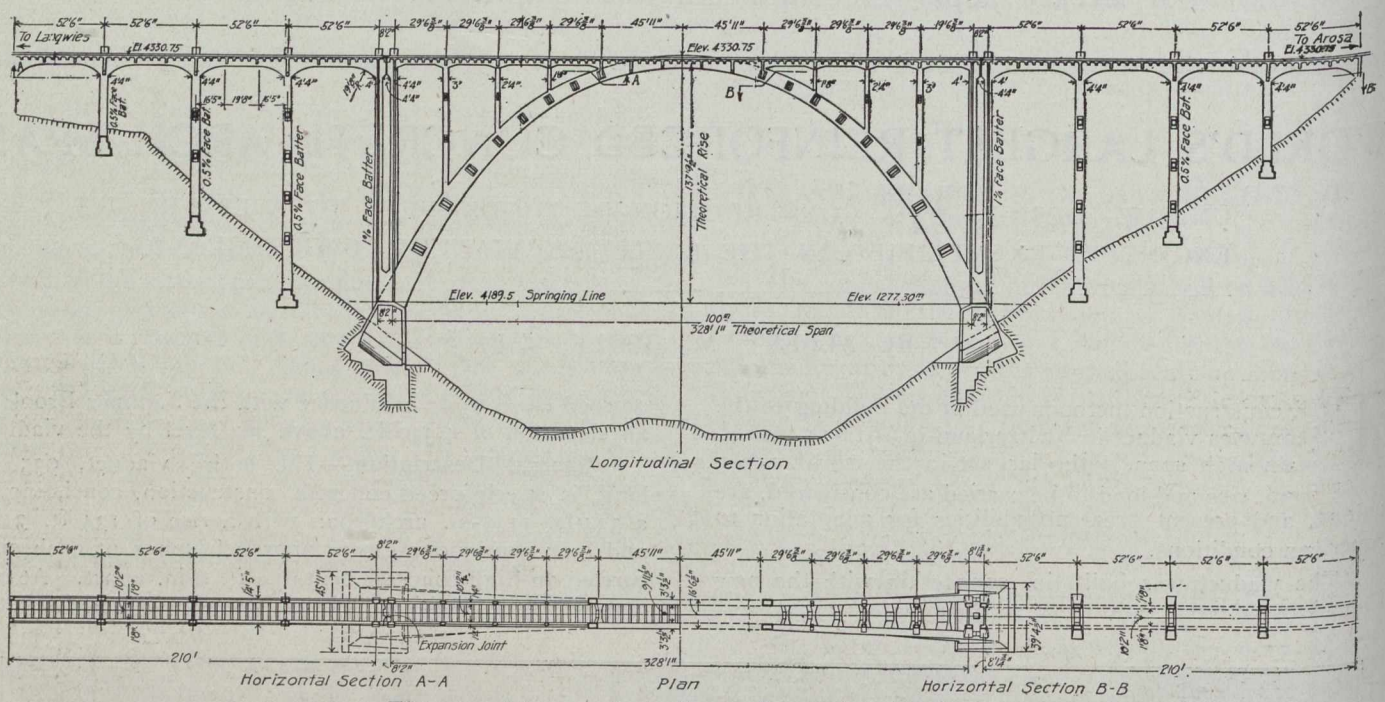

Fig. 2.—Plan and Sections, Langwies Viaduct.

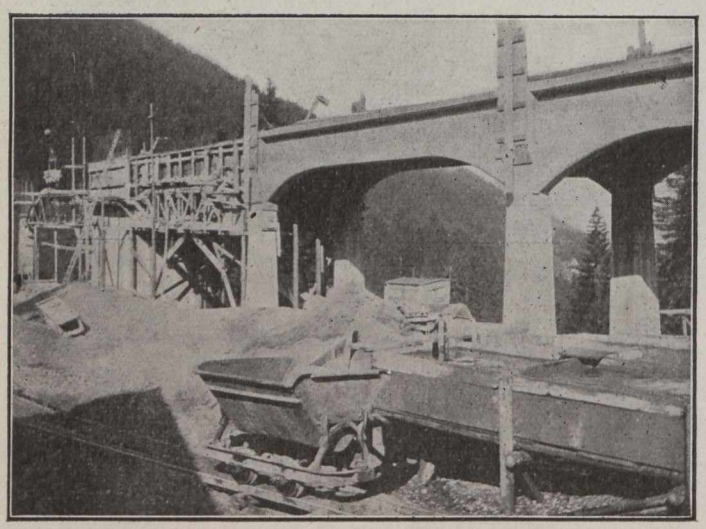

Fig. 3.—Long Span Continuous Girders of Approach.

Design Requirements and Loadings.—Lack of satisfactory building stones, and difficult and rough roads precluded the use of masonry arches or heavy steel girder bridges, while the abundance of good gravel and sand at the site led to the selection of a reinforced concrete viaduct as the most suitable type. At first the Swiss department of railways objected very strenuously to this plan, on the ground that the dimensions of the bridge were too great for safe construction of reinforced concrete. The contractors succeeded, however, in overcoming all the objections and in obtaining the consent of the authorities for the building of the structure, work on which began in the summer of 1912.

A long-span arch was the logical solution of the problem of bridging the deep mountain gorge and for economical reasons a twin ribbed arch was used. On account of the very favorable foundation conditions the main arch was proportioned and designed as a fixed arch in accordance with the method of the elastic theory, the temperature and rib shortening stresses being minimized by the great rise of the arch. The structure as designed, required no reinforcement for dead and live load stresses, being so proportioned as to keep the line of pressure well within the middle third of the ribs. To provide for such tensile stresses as might arise to temperature changes and rib shortening alone or combined with the dead and live load stresses, steel reinforcement was used in both extrados and intrados of the arch ribs. For the approach spans continuous girders were used because the great height of the roadway above the ground made a construc-