ARCH AND VAULT TESTS OF THE AUSTRIAN SOCIETY OF ENGINEERS AND ARCHITECTS.*

DURING the years 1891 and 1892 the Austrian Society of Engineers and Architects conducted a series of tests on brick and concrete arches and vaults that were in every way much more complete than any hitherto attempted. The results obtained have attracted much attention from engineers and architects, although the arches tested are not in general use in this country.

Some idea of the scale on which these tests were conducted may be gained from the statement of the contributions of money,

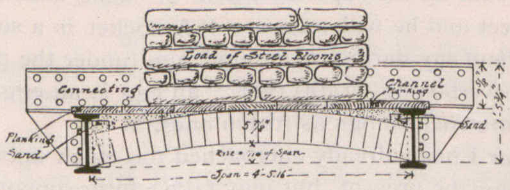

FIG. 1.—SECTION OF BRICK ARCH.

materials and labor from Government departments, railroads, manufacturing companies and private concerns, the total contributions from these sources amounting to $19,800.

The report covers (1) tests of eighteen floor arches, representing eight different types of floor construction; (2) tests of two culverts of 32.8 feet span and 1 in 10 rise; (3) tests of four bridges of 75 feet span and 1 in 5 rise; (4) an exhaustive series of tests to determine the strength and elasticity of all materials used in the above arches; (5) a theoretical calculation based on the results attained; (6) conclusion from the results in regard to theory and construction.

The object of the society in printing the report for general circulation is to bring about desired improvements.

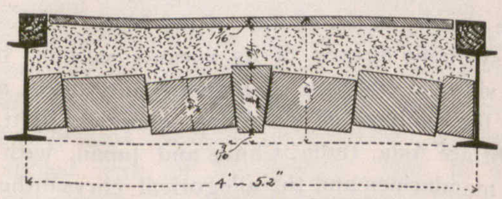

FIG. 2.—SCHOBER SYSTEM.

Of the various tests made those on the flat arches for floor construction will probably prove of most interest to architects. These tests include four arches of ordinary brick, five of flat tiles

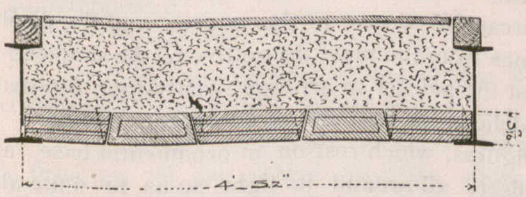

FIG. 3.—HONEL SYSTEM.

(differing entirely from those used in this country), three of concrete, three according to the Monier system, two of corrugated iron and one arch constructed according to the system Melan.

The above tests were divided into three series: A, seven arches with a span of 4 feet 5.16 inches; B, seven arches with a span of 8 feet 10.2 inches; C, four arches having a span of 13 feet 3.6 inches.

The arches in the first and second series were built between I-beams, which were rigidly secured and supported, so that no possible movement could take place. The third series was built between solid masonry abutments, as shown in Fig. 6.

This latter series of arches were regarded as a connecting link

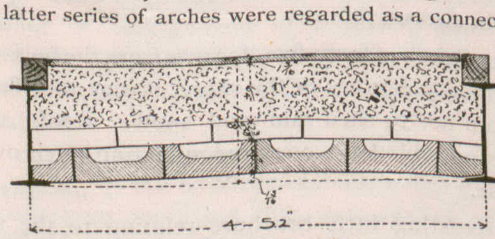

FIG. 4.—GLUCKSELIG SYSTEM.

between floor arches of small span and those of highway bridges, and the tests were instituted principally for making a comparison between arches of concrete, those of the Monier system and of brickwork. The tests of the flat arch systems were for spans of 4 feet 5.2 inches only, as these arches are not designed for much greater spans.

The construction of these arches is shown in Figs. 2 to 5.

Of the seven arches in the short-span series two were of brick (one header, one stretcher), one of concrete and one of each of the systems shown in Figs. 2-5.

The two brick arches laid up in white lime mortar showed practically no change under a load of 1,436 pounds per square foot.

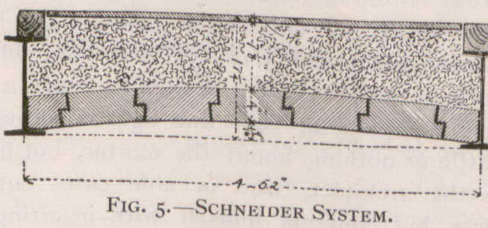

FIG. 5.—SCHNEIDER SYSTEM.

Of the ways of laying the bricks—headers or stretchers—the latter in every case showed a superiority, probably on account of the lesser number of joints.

The concrete arch, which was only 2 15/16 inches thick, with a rise of 4½ inches, was composed of one part Portland cement and five parts sand, and sustained 1,638 pounds per square foot without failure or cracking. The deflections of the concrete were about an average of the two brick arches, hence this arch may be considered as equal in strength to a brick arch 5⅞ inches thick, while it has the advantage of lesser weight.

The four flat arches showed an unexpectedly high carrying capacity.

The Schober arch (Fig. 2) and the Honel arch (Fig. 3) gave evidence of a very small deflection, even less than that of the brick arches, and a load of 1,638 pounds per square foot caused them to undergo very little change.

The Glückselig arch (Fig. 4) failed under 1,638 pounds per square foot, and the Schneider arch (Fig. 5) under 1,651 pounds per square foot, both arches showing considerable deflection beforehand.

It may therefore be concluded that these arches are completely safe for all practical purposes, provided the skewback beams are not placed too far apart and the workmanship is first-class.

When using either of these systems, however, one must not be too economical in the use of tie-rods, to prevent any lateral deflection of the floor beams.

All of the above arches were tested by loading with iron and steel blooms. To get as uniform a load as possible a layer of cinders, etc., was evenly distributed over the arch and a planking composed of floor boards was placed thereon. The load was applied over the whole surface, and the arch had at least four months to set before testing.

SECOND SERIES.—This series consisted of one concrete arch 3⅜ inches thick, one arch of ordinary bricks, one arch of Honel's bricks, two Monier arches (one leveled up with cinders, the other with concrete) and two arches of corrugated iron, one with the edges reinforced and the other without reinforcements.

All were sprung between I-beams placed 8 feet 10.2 inches apart between the webs.

Each of these arches was loaded over one-half of the arch only, although the arches were leveled up and the planking laid over the whole surface as in the first series.

The arch composed of ordinary bricks gave evidence of but little change under a load of 410 pounds per square foot, and carried 885 pounds per square foot before it failed. This arch was 5 5/16 inches thick, composed of a single course of brick, and had a rise of 9.85 inches.

To see if a thinner arch would answer the same purpose, one arch was constructed of "Honel's" bricks, which were only 3 15/16 inches thick, with a rise of 5 5/16 inches (1 in 20). This arch, however, failed under an eccentric load of 491 pounds per square foot, after having shown considerable deflection beforehand. It does not seem advisable, therefore, to use a 4-inch arch for so great a span.

The arch of concrete 3 5/16 inches thick, with a rise of 1 in 10, composition 1 to 4, fulfilled all requirements, as it sustained 614.4 pounds per square foot before it began to crack appreciably, and failed under an eccentric load of 1,130 pounds per square foot.

The two Monier arches deflected on an average equally as much as the concrete arch, and showed no appreciable superiority.

The arch leveled up with the concrete showed an increase in

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