

such materials do. The lowest in concrete, which was of pebble aggregate, was about 10 per cent., and the highest, which was of shale-chip aggregate, was about 25 per cent. of the crushing strength. Crushed limestone aggregate, as also quartz sand mortar, gave an intermediate value. A fair quality of gneiss stone sheared at about 1,000 pounds, limestone at about 1,200, Conshockicken laminated mica schist about 1,400, and Rushland black shale at about 2,500 pounds per square inch. A fair sample of red stretcher brick, such as is used for building houses, gave from 100 to 200 pounds; medium burned shale brick, from 400 to 900 pounds, and vitrified shale street paving 1,000 pounds per square inch. Specimens 6 inches square of plain 1:3:6 crushed limestone concrete, 1 inch aggregate, two months old, that would have about 2,000 pounds per square inch crushing strength, sheared at 200 pounds per square inch, with inclination of cut  $1\frac{3}{4}$  in 6, 300 pounds with inclination of  $1\frac{1}{2}$  in 6, and 400 pounds with inclination of  $1\frac{1}{4}$  in 6.

The special rig designed for the investigation of the effect of shear in combination with compression, itself failed by shear, want of knowledge and consequent lack of proper judgment having invited disaster and interrupted the work. All of the partial tests made indicate that where shear operates in a member stressed in compression, as in the case of an arch ring, ordinary concrete at ordinary unit stress does not give the margin that should be allowed. At the abutment skewback of a hingeless arch the compression in the arch is, or may be, resolved into horizontal and vertical components, and in present knowledge of the science conservative practice treats these components as actual shear, and provides for it with corresponding resistance in the arch section in horizontal and vertical lines.

In this view of the forces at work a concrete arch, especially of the lightened spandrel type that is being more and more widely adopted for both railway and highway bridges, unless it be clumsily heavy, will have higher unit shearing stress in it than modern practice warrants, when it knows it, for plain concrete. In a large arch with open spandrels the weight of the ring itself is a large part of the total load, and, therefore, increase of section will be attended with such an increase of load that higher value cannot be thus obtained economically. The alternative is some species of reinforcement, not longitudinal, but transverse. If steel be used for the purpose it should be horizontal in the column and radial in the arch. Longitudinal steel reinforcement is of doubtful value for any but tensile stress, and transverse reinforcement partakes of the nature of hooping, and must, therefore, increase the compressive strength as well as the shearing resistance. The simple expedient of making a composite or hybrid material of concrete with embedded flat stone seems to meet these requirements of transverse reinforcement, and it has been adopted in a number of cases with very satisfying results. It is a combination of stone masonry and concrete, and it has been found to combine also increased strength with reduced cost. The process consists of placing layers of concrete mixed wet and sinking into each layer as many flat stones of any convenient size as can be embedded properly. Without special effort to secure it, a very satisfactory overlapping for bond is obtained by the mere law of chance in depositing, and skilled masons are not required. This construction produces the most compact possible class of masonry. A large number of compression tests have been made on 6 and 12-inch cubes, made with embedded flat stone having a shearing resistance about six times that of the mortar of the concrete, and they gave from 30 per cent. to 50 per cent. higher ultimate crushing resistance than the similar cubes of plain concrete. A number of shearing tests of small prisms made of the same construction show even greater gain in the shearing value. Certainly, if the line of cleavage passes through the embedded stone the result will be high for concrete,

provided, of course, that the embedded stone has a higher value than concrete, and stone that has not as high a shearing value as 1,000 pounds should not be used for the purpose. The further facts that this hybrid construction increases the lateral tensile strength which operates to resist settlement or other cracks and reduces the shrinkage of the mass, thus minimizing internal stresses, are incidental but important.

The science of structural design is still incomplete, not because the mathematics may be inexact, but because the materials to which the mathematics must be applied are not yet thoroughly known as to their characteristics. We learn Nature's laws by running against them—not by reasoning, and, therefore, investigation is necessary to equip us for handling its products properly, and, as the margin between success and failure—between safety and disaster—may be, and undoubtedly often is, very narrow, it behooves us to study thoroughly by tests all the peculiarities of our materials of construction.

## THE COMING CONVENTION AND EXHIBITION.

Toronto will be the meeting place for the first Convention and Exhibition to be held under the auspices of the recently formed Canadian Cement and Concrete Association during the first week of February. This decision was reached at a meeting of the Executive held at Toronto, Monday evening, September 7th. This is the first convention of its kind to be undertaken in Canada. It will be a meeting-place for all Canadian cement and concrete interests, where some of the highest authorities on cement and concrete will be present to address the assembly and to give their best unbiased knowledge on many of the more important subjects. Questions of general interest that have for their object the betterment of the industry at large, will be given due attention. They will form the foundation for what is hoped to be a Canadian National organization for advancing the best interests of the industry in Canada. The primary object of the Association is to give to the general public reliable, serviceable and economical methods of construction. If it accomplishes this work it has fulfilled its mission. Now that definite plans are under way for the first Convention and Exhibition, cement men everywhere are requested to lend a hand to the good work of making the first Canadian Cement and Concrete Convention one to be proud of.

## IRON ORE CEMENT.

A number of cements made in Germany are recommended by the various companies as suitable for hydraulic purposes. The "sea-water proof" cement or ore cement (Erzcement) is manufactured about fifty miles from Hamburg. It is claimed that the Erzcement is a product which can be used with economy and efficiency for works constructed in sea water, in tunnels, etc., where ordinary Portland cement will deteriorate. The raw materials used in the manufacture of the product are: (1) Pure chalk, that is, chalk containing 99½ to 100 per cent. of pure carbonate of lime; (2) roasted flint stone, very finely ground; and (3) finely ground ferric oxide.

## RAILROAD EARNINGS.

	Week ending.	1907.	1908.	Change.
C.N.R.	.....Sept. 7	\$188,700	\$175,300	— \$13,400
C.P.R.	.....Aug. 31	2,243,000	2,008,080	— 235,000
G.T.R.	.....Sept. 7	831,054	990,736	+ 159,682
T. & N. O.	....Aug. 31	31,000	26,000	— 5,000
Montreal Street.	Sept. 5	73,248	74,739	+ 1,491