mixer drum on the strength of concrete and the effect of time of mixing on the wear of concrete. It coincides with the writer's paper (see *The Canadian Engineer*, July 11th, 1918) in giving the first available data relating to the influence of the consistency of the mix on the wear of concrete. The range of the writer's tests is small as compared with those made by Prof. Abrams.

The results of the author's tests to ascertain the influence of the consistency of mix upon the strength of concrete are of special interest to the writer, since they confirm the information obtained from his own tests. (See *The Canadian Engineer*, August 16th, 1917, and July 18th, 1918). The results of the latter tests, being platted with different ordinates, are not directly comparable with the diagram presented in the author's paper. For the purpose of comparison the diagram shown in Fig. 1 has been prepared from the information contained in Fig. 31 of the author's paper (*The Canadian Engineer*, August 1st, 1918), which is here reproduced as Fig. 2, and from Fig. 2 of the writer's paper (*The Canadian Engineer*, July 18th, 1918), which is here reproduced as Fig. 3.

The higher strengths at the 7 and 30 days ages shown for the writer's tests are doubtless due to a difference in the setting and hardening properties of the cement used rather than to any influence of the water content of the mix.

The writer is in full accord with the author's statement: "The only safe rule to follow with reference to water in concrete is to use the smallest quantity of mixing water which will give a plastic or workable mix, then provide plenty of moisture for the concrete during the period of curing which follows setting and hardening of the cement."

In no other way is it possible to secure a dense cement matrix which will produce a concrete possessing the greatest possible strength, toughness and other desirable physical properties.

The author's conclusion, "There is no further increase in strength after the concrete is thoroughly dried out," although directly contrary to a common popular conception, is borne out by the results secured by other investigators.

The writer has consistently claimed that design and construction are of equal importance in the production of an efficient and thoroughly reliable concrete or reinforced concrete structure. The author's paper gives rather indirect but ample evidence that with carefully drawn plans and specifications, constant vigilance is necessary to insure good construction work and to obtain as nearly perfect results as possible.

LLEWELLYN N. EDWARDS,
Supervising Engineer of Bridges,
City of Toronto.

Toronto, Ont., September 9th, 1918.

Open Spandrel Arches

Sir,—As supplementary to Mr. Barber's list, I append herewith a list of reinforced concrete bridges of the open spandrel arch principle, in the province of Manitoba, built under the Good Roads Department of the Provincial Government.

Although the principle involved is the same in each case, three distinct types of bridges are represented in the list—the open spandrel arch proper, in which the deck is above the level of the crown; the "half-through arch," in which the deck occupies an intermediate level between the crown and springing line; and the "bowstring," in which the deck is at springing level. The last two types are an adaptation of the principle to a condition frequently obtaining on the prairie, maximum waterway requirements with limited headroom. It is believed that the Riverview Arch is the first bowstring to be constructed in the Dominion, and that it is the longest span of this type on the American continent. Some of the bridges in the list are at present under construction but as Mr. Barber's list purports to be complete to 1918, they are included:—

	Clear Span Main Arch.	Number of Spans.	Type.
Arden Arch No. 2, 1916..	55 ft.	3	Spandrel
McKinnon's Arch, 1916 ..	40 "	3	"
Riverview, 1917	86½ "	1	Bowstring
Rat Creek, 1918	50 "	3	"
Mill Creek, 1918	50 "	1	"
La Salle River, 1918.....	50 "	1	"
Willow Creek, 1918	50 "	1	"
Arden Arch No. 3, 1918..	50 "	3	Half through
Arden Arch No. 4, 1918..	50 "	3	" "
Edward's Creek, 1918	38 "	1	" "

All the foregoing were designed by and executed under the supervision of the staff of the Good Roads Department, A. McGillivray, highway commissioner, and M. A. Lyons, chief engineer.

P. BURKE GAFFNEY,
Bridge Engineer, Good Roads Dept.,
Manitoba Provincial Government.

Winnipeg, Man., September 6th, 1918.

Contracting in War-Time

Sir,—At no time in the history of the building trades, owing to the war and general conditions, has the occasion called for more resourcefulness or latent ability on the part of superintendents and managers of construction. The fact cannot be disputed that our best men have gone to war,—those who would have taken the lead and those who are the most active and alert. A class of workers are on the market who would have been at a discount before these war conditions. It has remained for the unfortunate manager to deal with this class largely.

First-class mechanics, if not in the army, have at any rate disappeared from sight,—men who had learned their trades thoroughly. It is rather to be deplored that the unions have been so busy arranging hours of labor, wages, disputes, etc., that little was ever done to keep the supply efficient.

If it had not been for the efforts of public-spirited men who have advocated trade and technical schools, we would be worse off than ever. We often hear the remark, in referring to the shortage of skilled men: "You can get the men if you pay the price." I venture to submit that this is not now true; the men one gets now even when the price is paid are too often of the class I have mentioned before: incompetent boosters, men who have by the situation named acquired "cheek." Under the above conditions, and the writer is speaking from long experience, it has been impossible to make any money, and money has been lost on nearly every job taken by contract which was estimated even on a good chance of profit and away ahead of pre-war prices.

We all know lots of things have entered in to make the cost higher,—materials, delivery, etc., but I am dealing with labor only at this time. "Well," the reader will say after this apparently pessimistic arraignment of the