

curbing must be built up as the laying of the concrete proceeds. Within the casing and firmly tamped against it, there should be placed fine concrete to a thickness of about six inches. This will form a shell for the abutment, inside of which large stones may be placed in rack-and-pinion order, ends up. There should be a space of at least two inches between the stone, filled with fine concrete, and all firmly rammed. The outer shell of fine concrete should always be kept built up six inches or so in advance of the rubble work. The rubble should be placed in three layers, each layer well flushed with a layer of fine concrete.

The lumber used in making the curbing or casing should be dressed, tightly fitted and firmly braced, so that the concrete may be well rammed into place. The framework should be closely boarded up against the work as it proceeds. The centering for the arch should be well formed. The ribs should not be further than three feet apart. The lagging should be three inches thick and dressed to the intrados of the arch. All the framework, centering and supports should be substantial and well constructed. This framework is a considerable item of expense in the building of a culvert, but it can be used as often as it may be required for arches of similar span. The exterior of the culvert when finished should have a smooth face, free from holes, and a surface coating, which is of little use, should not be necessary.

There is some difference of opinion as to the relative strengths of gravel and broken stone in concrete. The natural in-

ference is to suppose that a rough, irregular surface will secure greater adhesion than one that is smooth. However that may be, there is little reason to doubt that gravel will make a good concrete, but there is a right and a wrong way of using gravel. It is not uncommon to find cement and gravel just as it is taken from the pit, mixed to form a concrete. Remembering the proper composition of a concrete, and placing beside this the fact that gravel usually contains sand, but not in any definite proportions, and that some pockets of "gravel" may be almost completely sand, while in the layers adjoining there may be little if any sand, and that many gravel beds contain much clay or earthy material, it will be readily understood why it is that, in some cases, concrete mixed in this way may be successful, yet it will always be uncertain and hazardous. The only safe method is to separate the stone and sand composing the gravel by screening, then to mix cement, sand and clean stone uniformly and in their right proportions.

A cause of poor concrete is the excessive amount of water used when mixing. The tendency very often is to bring concrete to the same consistency as common mortar. Concrete when ready to be placed in the work should have the appearance of freshly dug earth. Where an excessive amount of water is used, the hardened concrete will have an open, spongy texture.

The concrete should be mixed at a point convenient to the work in a box which is sometimes specified as water-tight, but the concrete will quickly make it so. I

should be mixed in just such quantity as required, and a constant stream kept passing to the work. It should be laid in layers, each layer thoroughly rammed until moisture appears on the surface.

It is very necessary to see that the sand and stone used in making concrete are clean, that it is free from clay, loam, vegetable or other matter which will act as an adulterant, and result in a weak and friable concrete. If such matter is intermixed with the stone it is well to flush it away with a good stream of water. Large stone used in rubble concrete should be also treated in this way. It is well, particularly in hot weather, to dampen the stone before mixing it with the mortar. The heat of the stone in hot weather causes the moisture of the mortar to evaporate, causes it to set too quickly, and at all times there is more or less absorption from the mortar in immediate contact with the stone, unless the stone, as intimated, has been dampened.

When the work ceases for the day, or is for other reasons interrupted, the surface of the concrete should be kept damp until work is resumed. When work is in progress in hot weather, any exposed surfaces should be kept damp and protected from the rays of the sun, otherwise the surface will, in setting too rapidly, be interlaced with hair-like cracks which, filling with water in the winter, and freezing, will cause the surface to scale off. The same scaling sometimes results from laying concrete in frosty weather.

Arch culverts of masonry or concrete fail frequently from settlement caused by an insecure foundation. The foundation should always be of at least sufficient depth to be free from any danger of undermining by the action of the water, and of sufficient depth to be safe from settlement,

JOHN GALT, C.E. & M.E.
MEM. CAN. SOC. C.E. AND C.E.A., ETC.
CONSULTING ENGINEER and EXPERT
National Trust Building
30 King Street East Toronto
Specialties—Water Supply and Sewerage.

THE
Matthew's
Fire
Hydrant



Is the recognized Standard Hydrant, and is the easiest Hydrant to keep in order.

Our Hydrants are thoroughly tested before shipment, and are of substantial proportions and weight.

Have your Engineer specify "The Matthew's" and get our order.

THE KERR ENGINE CO., LIMITED
Walkerville - Ont.

JOSSON CEMENT .. Manufactured at
NIEL ON RUPELL
Is the Highest Grade Artificial Portland Cement and the Best for High Class Work. Has been used largely for Government and Municipal Works.
TO BE HAD FROM ALL CANADIAN DEALERS
C. I. de Sola, Manager in Canada :: 180 St. James Street, MONTREAL

BLAST . . . SLAG . . . A MOLTEN FURNACE . . . ROCK . . .
Cement Sidewalks, Road Foundation and Concrete Work

**STRONG AS STONE
CHEAP AS GRAVEL**
Doolittle & Wilcox, Hamilton, Ont.

Portland Cement..
ALL GRADES.
Write or Telegraph to
BELLHOUSE, DILLON & CO.
201-203 Coristine Building, St. Nicholas Street, Montreal
for prices—Large stock constantly on hand.



Largest Makers in the World.

August
W
V
S
CA
District
THOS. J. I
Special
Cast
Flange Pij
Branch
Hydrants
Valves
W
HEAD OF
JAMES. 1
THE
Manu
I
Special
Waterw