force with which this expansion takes place is so great that it is sometimes utilized for blasting purposes. I found, also, that wherever cracks appeared in the concrete the limestone aggregates were at least partly covered with a layer containing hydrated lime. It is, therefore evident that the cracks in the concrete were in these instances caused by the expansion, which took place when the quick lime formed by the fire was hydrated. The loose structure of the concrete was at least partly due to the same cause. But even the formation of a thin layer of quicklime round the aggregates must injure the concrete, as we know that this substance is much softer and weaker than the limestone. It would in this state act in a similar way as a coating of clay. The concrete would therefore from this cause alone be liable to break down during the fire, without any hydration taking place.

The kind of limestone found in the concrete will burn at about 1,490° F. (810° C.), wherefore the temperature in the effected concrete must have reached at least that point.

It is therefore evident that gravel containing limestone of a similar composition (the approximate B.T.U. was in this case = 7,800) should not be used where a possible fire of the combustible materials, stored in a building, will be able to raise the temperature in the vital concrete construction up to or above 1,490° F. For aggregates containing magnesia limestone the temperature limit is still lower. The poorer the limestone the easier will it "burn," but the less is the expansion when it hydrates. If the aggregates in this special case had been of a silicous character, as, for instance, granite, trap or other similar substances, the concrete would have, without doubt, withstood the fire, if not of too long duration.

The thermal value of the main part of the material stored in the building was found from actual test to be 8,092 B.T.U.

It was pointed out above that the loose structure of the concrete was due to the expansion caused by the hydration of quick lime. I found, however, indications that the concrete had been worked too wet. We know, however, that too much water will weaken the structure and make it porous and less able to take care of the different stresses. The above-mentioned strata found point to a mixture too high in water. The analysis of them gave the following results:

No. 4968.

Volatile matters	18.21%
SiO_2 (silica)	19.00%
Al_2O_3 (oxide of aluminum)	6.88%
Fi_2O_3 (oxide of iron)	1.43%
CaO (lime)	50.83%
MgO (magnesia)	2.32%
SO_3 (sulphuric acid)	1.29%

The composition of this material in the dry state would be as follows:

Volatile matters	1.46%
SiO_2 (silica)	22.84%
Al_2O_3 (oxide of aluminum)	8.29%
Fi_2O_3 (oxide of iron)	1.72%
CaO (lime)	61.24%
MgO (magnesia)	2.79%
SO_3 (sulphuric acid)	1.55%

From the analysis we may draw the conclusion that the stratified material was Portland cement. This circumstance indicates, also, that the mixing of the concrete might have been done better.

Porous and weak concrete is also caused by lack of cement. In this special case I do not know of any method by which we can determine the proportions of cement to aggregates. I analyzed the concrete and the results are:

No. 4983.

H_2O (organic matters)	4.10%
CO_2 (carbonic acid)	23.18%
SiO_2 (silica)	22.18%
Al_2O_3 (oxide of aluminium)	5.45%
Fi_2O_3 (oxide of iron)	1.56%
CaO (lime)	41.04%
MgO (magnesia)	1.34%
SO_3 (sulphuric acid)	0.24%

The CaO factor = 4.82 cc n/2 HCl.
Sp. gravity, 2.6211.

The only conclusion I can draw in this special case is that the concrete mixture was poorer than 1 : 6. I may add that, estimating the proportions from three different points of view gives the same result.

From the results obtained in the above outlined investigation I draw the following conclusions: The concrete suffered from the fire because the limestone aggregates were on their surfaces through the comparatively strong heat changed to quick lime, and this in its turn was hydrated when acted upon by water. The resulting great expansion caused the cracks and the loosening-up of the concrete.

In connection with this subject I may be allowed the following remarks and suggestions, based on the above findings:

There is in the public mind a rather uncertain idea as to the property of a fireproof structure. Some seem to think that it is fireproof if the materials in the same are not subject to combustion and others, that they must not only be inflammable, but that they should also endure fire from other materials without injury. There is, however, no building material in general use that is immune from the intensity of heat possible from combustion. The second definition in its fullest meaning must therefore be thought of more as an ideal than a practical possibility. The first view, on the other hand, includes some building materials which, while they do not burn are easily damaged by fire. Would it not, therefore, be well to go between the two and consider them as the lower and upper limits? Looking at the subject from this point, a fireproof building would be a construction of noncombustible materials that will endure the influence of fire up to a certain limit without being damaged. The limit or degree of heat it might be called upon to withstand will depend on the nature and quantity of combustible materials stored inside the same or in its immediate surrounding, and may therefore be estimated beforehand by the architect. By approaching the subject from this point of view the meaning of the word "fireproof" becomes more elastic and assumes an appropriate degree of individuality for each special case. It gives an adequate protection to the owner, and it will also serve to prevent useless expenditure, as the most suitable material can in each instance be selected to fit that special case.

Concrete has in many a fire proved its good qualities, and it would have done the same in this special case if the proper aggregates had been selected to suit the probable conditions.

Hoping the above will serve a good purpose.

A. G. LARSSON, C.E.

St. Mary's, Ont., February 12th, 1917.