

**REPORT ON CONCRETE FOUNDATIONS
FOR PAVEMENTS: WITH SPECIAL
REFERENCE TO WORK OF THAT NATURE
IN THE BOROUGH OF BROOKLYN; CITY
OF NEW YORK; DURING THE YEAR 1902**

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Report on Concrete Foundations for Pavements: With Special Reference to Work of that nature in the Borough of Brooklyn; City of New York; During the year 1902 by Various

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VARIOUS

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ON
CONCRETE FOUNDATIONS
FOR PAVEMENTS

WITH SPECIAL REFERENCE TO WORK
OF THAT NATURE

IN THE
BOROUGH OF BROOKLYN
CITY OF NEW YORK

DURING THE YEAR

1902

BY THE
COMMISSIONERS OF ACCOUNTS

MAY 15, 1903

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WM. HEPBURN RUSSELL,
EDWARD OWEN,
Commissioners.

NEW YORK, May 15, 1903.

SUBJECT: *Report on concrete foundations for pavements
with special reference to work of that nature
in the Borough of Brooklyn, City of New
York, during the year 1902.*

Hon. SETH LOW,
Mayor :

SIR—We herewith transmit to you a report made by our Engineering Bureau on the composition of concrete and the quality of its constituents used in street paving in the Borough of Brooklyn.

The various tests and analyses described therein have been carried on in our Physical and Chemical Laboratory during the last winter alongside of the regular routine business, as time would permit, and we consider the findings and conclusions of importance.

Respectfully submitted,

WM. HEPBURN RUSSELL,
EDWARD OWEN,
Commissioners of Accounts.

SUBJECT: *Report on concrete foundations for pavements with special reference to work of that nature in the Borough of Brooklyn, City of New York, during the year 1902.*

Hon. COMMISSIONERS OF ACCOUNTS,
New York City :

GENTLEMEN—During the past year (1902) an exceptionally large number of contracts for repaving streets with various materials, on a concrete foundation, were let in the Borough of Brooklyn.

The clauses of the specifications, which relate to the composition of the concrete and the quality of its constituents, are the same in all the contracts herein referred to, and are herewith quoted :

“ 14. *Concrete*—The concrete shall be made of the
“ best quality of Portland cement, samples of which
“ must be submitted at least ten (10) days (Sundays and
“ holidays excluded) before using, for the inspection
“ and approval of the Chief Engineer. All cement
“ shall be of uniform quality, color and weight, and
“ briquettes of one (1) square inch section shall develop
“ or exceed the following tensile strength :

“ Neat—one hour in air, twenty-three (23) hours in water.....	200 pounds
“ Neat—one day in air, six (6) days in water... 400	“
“ One of cement, three (3) of sand, one day in air, six (6) days in water.....	150 “

“ The concrete shall be composed of one (1) part of
“ cement, three (3) parts of sand and six (6) parts of
“ broken stone. The unit of measure shall be the bar-
“ rel of cement as packed by and received from the
“ manufacturer.

“ The sand shall be clean, coarse and sharp, and be
“ free from loam or dirt. The broken stone shall be
“ of trap, granite or limestone, or such other stone
“ taken from the line of work as shall be satisfactory in
“ the judgment of the Engineer. It shall be entirely

" free from dust and dirt and be of graded sizes such
 " that all will pass through a revolving circular screen
 " having holes two and a half ($2\frac{1}{2}$) inches in diameter,
 " and be retained by a screen having holes one-half ($\frac{1}{2}$)
 " inch in diameter. The sand and stone shall be placed
 " upon board platforms and be kept free from dirt, and
 " the cement shall be properly blocked up and pro-
 " tected from dampness.

" The sand and cement shall be mixed dry, then made
 " into mortar by the addition of water, when the broken
 " stone shall be added and the whole mass thoroughly
 " mixed. The concrete shall then be spread upon the
 " subgrade and rammed so as to fill all the voids of the
 " stone with mortar and bring the surface exactly—
 " inches below the finished pavement. If a machine
 " be used for mixing, the above operation may be
 " varied as may be required. No concrete shall be used
 " that has been mixed more than one-half hour. The
 " concrete shall be protected from the weather when
 " deemed necessary by the Engineer.

" No horses, carting or wheeling shall be allowed on
 " the concrete before the same has set, except on planks
 " furnished and laid by the Contractor.

" The concrete foundation shall be six (6) inches
 " thick, except where otherwise specially ordered.

The severe and persistent criticism of the Examining In-
 spectors and Engineers of this office in regard to the concrete
 foundations on many of these contracts points to the con-
 clusion that much of the concrete thus laid in Brooklyn
 during the past season is of poor quality, and is not of the
 character that a strict enforcement of the specifications
 regarding its constituents would compel.

That this conclusion is altogether correct is strongly
 evidenced by the action that the Bureau of Highways of the
 Borough of Brooklyn has been compelled to take within a
 comparatively recent period, namely, to require the con-
 tractor to replace either a part or the whole of the concrete
 he had laid, notwithstanding the fact that the cement used

had been passed by the Bureau of Highways, and the work had been under its constant daily inspection from inception.

The criticism of this office has included almost every item mentioned in the portion of the specifications quoted above, as well as the quality of the concrete itself, of which no mention is made in the same.

By this it is not meant that the specifications were violated in every respect on every contract, but rather that there were few contracts where no item of this Concrete clause was violated, and a large number where many were violated.

To begin with, I will call your attention to the quality of the materials of which the concrete in general which has been criticised is composed.

The broken stone is usually free from dust and loam or dirt, although some exceptions to this have been noted, but in addition to being free from dust the broken stone is usually also free from the smaller sizes ($\frac{1}{2}$ inch to $1\frac{1}{4}$ inches in diameter) of stone which are of the greatest value in filling the voids between the larger stones. The reason for this lack of smaller stones is that oftentimes they are screened out to be used for the binder of asphalt pavements. The trap and limestone crushed and screened at the quarry are usually satisfactory, except in this respect, but the specifications allow of the use of any stone taken from the line of the work which shall be satisfactory to the Engineer, and this opens the way to the use of large quantities of stone, usually old cobble pavements, parts of which are altogether unfitted for concrete, since much of it is of a particularly inferior quality. Then, in addition, the contractor does not pay the amount of attention to the crushing which he would do if he had to market his product, and once his crusher is set up, he is not particular as to whether his source of supply is limited to the stone on the line of the work or not. The result is that the broken stone as brought to the work is a vari-colored mixture of stone of all descriptions containing almost invariably a considerable percentage of stone greatly exceeding the specified limit of $2\frac{1}{2}$ inches, and from which nearly all of the finer stone (that is less than $1\frac{1}{2}$ inches

diameter) has been removed. The stone is usually placed on board platforms as required.

The sand, however, is almost invariably dumped from the carts directly onto the ground forming the sub-grade of the street, and is seldom placed on boards before it reaches the mixing board. The sand is usually fairly clean and sharp, but might be coarser to advantage.

The cement, which is, of course, by far the most important ingredient of the concrete, is required by the specifications to be the "*best quality* of Portland Cement," and if this requirement were strictly enforced, there would be little to criticise, aside from what has been previously mentioned.

The minimum limit required for the tensile strength of briquettes of one square inch section is so low, however, as to permit of the use of second-quality cement, and it is an unfortunate fact that if a cement passes these easy tests it is usually accepted by the Bureau of Highways without any further examination as to its classification as a Portland Cement of the *best quality*. It is a well-known fact that there are many cements which show excellent results when tested neat, and fail miserably in a mortar test; that is, when mixed with sand.

The latter is obviously the most important and conclusive test of a cement which is to be used for concrete, and the fact that there are certain cements on the market which will just about pass muster on the basis of the tensile strength required by the specifications, and yet when made into concrete provide about as poor a quality of the same as is deserving of the name, leads me to believe that the specifications are too low in their requisition of tensile strength, particularly in the mortar tests. With any well-recognized brand of "*best quality* Portland Cement," no difficulty is experienced in maintaining the tensile strength of mortar briquettes mixed in the proportions of one part of cement to three of sand, at an average much higher than the figure asked for by the specifications.

The clause quoted in the first part of this report states that "the concrete shall be composed of one part of

cement, three parts of sand and six parts of broken stone. The unit of measure shall be the barrel of cement as packed by and received from the manufacturer."

It is seldom, if ever, that cement in barrels is seen on these contracts. The universal custom seems to favor the use of cement in bags supposed to contain a quarter of a barrel. This, I understand, is largely a matter of economy with the contractor since cement in wood is sold at an advance of 25 cents per barrel to cover the cost of same without a rebate for the return of the empty barrels, whereas the bags are charged for at the rate of 10 cents each, all of which is rebated with the return of the bags. It will be seen that the contractor thus effects a considerable saving in a contract of any size by the use of cement in bags.

It is also probable that the facility with which packages of this size may be handled is partly responsible for this condition, rather than a preference to mix in smaller quantities, since it often occurs that four bags of cement are used in the mixing of one batch, especially when the same is done by hand. There is a decided advantage to be gained, however, by the use of cement in barrels due to the superiority of the barrel over the bag in protecting the cement from careless handling, dampness and the inclemency of the weather, as, in spite of the specifications, the cement is seldom properly blocked up and the protection from rain and dampness is rarely adequate.

The measurement of the proportions for the concrete is subject to considerable variation on different contracts, three different units having been used on some work, one for each class of material. Probably 75 per cent. of the contractors who mix their concrete by hand measure the proportion as follows, using these quantities of each class of material, or convenient multiples of the same :

One bag of cement, one wheelbarrow of sand and two wheelbarrows of stone.

When three bags of cement are emptied into a wheelbarrow, they fill it so that the barrow presents the appearance of being well filled but not heaped. Consequently, if the sand