"Stone-Quarry Investigations"

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Stone-Quarry Investigations

IN 1914 a co-operative agreement was entered into between the United States Geological Survey, the Bureau of Standards, and the Bureau of Mines for a study of the stone-quarrying industry of the country. The work undertaken by the Bureau of Mines had for its chief objects the promotion of safety and efficiency, and the elimination of waste in the industry, as well as a study of the technologic methods used, and of the problems involved.

There are approximately 3,000 quarries in active operation in the United States, employing in all about 100,000 men. Quarrying is, therefore, an industry of considerable magnitude. One can scarcely overestimate the importance of quarry products in the Nation's life and work.

Quarries supply, in the form of building stone, the most permanent and attractive of all structural materials. When this fact is appreciated more fully by architects and builders, natural stone will replace much of the cheap and temporary material of which many buildings are now constructed, and as a result buildings will have greater beauty and permanence, and the ultimate cost will be less than where cheaper materials are employed. For interior decoration natural stone excels all other materials in color effect, or in its capability of being shaped into artistic designs. For monuments or sculpture nothing can take its place. For the production of Portland cement, which is now indispensable in many lines of industry, millions of tons of rock is quarried annually. Street and road construction, for which millions of dollars is spent every year, depend to a great extent upon quarry products, both for crushed stone and for cement. The production of lime, ground limestone, and gypsum for soil amendment, and limestone for blast-furnace flux, is continually increasing in magnitude.

It is evident, therefore, that in attempting to safeguard the lives and health of quarry workers and to promote the highest efficiency and economy in the quarry industry, the Bureau of Mines has initiated a movement that directly benefits a great group of industries and a vast multitude of individuals and that indirectly benefits many more.

During the fiscal year two reports on stone-quarrying have been published by the bureau. The first publication, "Safety in Stone Quarrying," appeared in September, 1915. Its purpose was to point out to the stoneworkers of the country the chief sources of danger, particularly in the marble-quarrying industry, and to emphasize ways and means of materially reducing the number of casualties. The death rate due to accidents among quarrymen for the year 1913 was 1.72 per 1,000, which is higher than in most European countries for which records are available.

In determining the cause of accidents it was found that they could be grouped in three main classes. In the first place, many accidents result from faulty equipment. In this class may be placed boiler explosions, falls of derricks, and accidents due to insufficiently protected rotating machinery, electric wires, and quarry stairs and ladders. A second cause of accidents is faulty methods, such as improper handling, loading, and firing of explosives, and dangerous methods of handling rock or overburden. The third group comprises accidents that result from carelessness on the part of employers and employees. The report has received favorable comment from quarry operators, and requests have been receivd for many extra copies to be distributed among quarry superintendents.

RESIDENCE OF JOHN T. PRATT, NEW YORK

At 9 and 11 East Sixty-first Street. Architect: Charles A. Platt, New York. Cut stone contractors: George Brown & Co., Newark. Built of Buff Indiana limestone

A second publication, "The Technology of Marble Quarrying," was issued in March, 1916. At present

this is the only publication in the English language that takes up a specific branch of the quarrying industry and deals with it exhaustively. Following a discussion of the origin, properties, and imperfections of marble, the various processes of quarrying are taken up in order, as follows: Prospecting, stripping, channeling, drilling, wedging, hoisting, tunneling, drainage, transportation and manufacturing into finished form.

An important feature of this report is the emphasis placed upon the influence that rock structures should have upon quarry methods. This consideration has been generally overlooked by quarry operators, with consequent heavy losses through inefficiency. For example, in quarries having inclined open-bed planes which make it impossible to maintain level floors, it has been customary to construct supports in order that channeling machines may be operated on level tracks. Some of the more progressive companies have recently operated channeling machines on inclined tracks placed flat on the slanting quarry floor, without costly supports. A "balance car" overcomes the effect of gravity. This improved method, as shown by careful records, has resulted in a 50 per cent increase in efficiency in certain quarries of this type.

Other structures that influence quarry methods are "joints" or cracks which commonly intersect marble deposits in two directions, approximately at right angles. If marble blocks are intersected by such seams, their value is greatly impaired, and consequently an effort is always made to quarry sound blocks. Many quarrymen have taken no pains to determine the compass direction of the major joints, and consequently the channel cuts commonly cross them at oblique angles, and thus many blocks are unnecessarily marred by seams. The bureau has emphasized the fact that in the process of channeling or wedging out blocks the cuts should be made parallel with and at right angles to the joints.

The problem of waste is given special emphasis. The presence of vast piles of waste marble at many quarries indicate the two important phases of the problem: First, the desirability of reducing waste by introducing improved quarry methods, and, second, the need of utilizing the accumulation of waste material. It is pointed out that the proportion of waste may be reduced by intelligent prospecting and by separating blocks in accordance with rock structures. The various outlets for defective marble are also discussed. Thus, blocks containing imperfections may be employed for riprap, road building, lime burning, soil amendment, furnace flux, rubble, and various other uses.

An important feature of the report is a detailed record of a successful method of reducing the excessive loss due to "strain breaks" in marble quarries. The rock in many quarries is under compression, and as the compressive strain is relieved locally in quarrying, the partly severed blocks break into irregular masses, the fractures often being accompanied by loud reports. A method of avoiding the excessive waste due to the production of these irregular fragments is described. It is advised that rows of deep, closely spaced, vertical drill holes be projected in a line across the quarry in such a manner that the rock may expand and partly close the drill holes, thus giving relief from strain without the destructive fracturing. One Tennessee marble company, has already tried this method, and has thereby greatly reduced the proportion of waste marble, and thus effected a saving of several thousand dollars. It is believed that several valuable quarries that have during recent years been abandoned on account of excessive strain breaks could be reopened and worked profitably if the methods proposed in Bulletin 106 were adopted.

The report emphasizes the fact that waste reduction and efficiency of operation can not be accomplished if definite cost data are not kept. The point is emphasized that the majority of quarrymen fail to keep definite cost records, and as a result they are unable to properly judge the efficiency of methods and machines. The introduction of more modern methods of quarrying is therefore frequently discouraged by the inability of the operator to test their efficiency. To facilitate the keeping of technical records a complete system of quarry accounting is given.

During the summer of 1915, sandstone quarrying was studied by the bureau's technologist. About 55 sandstone quarries were visited by the bureau's technologist, and investigations were made of all phases of the industry. A special study was made of the physical properties and imperfections of sandstone and their effect on quarry operations. Methods of quarrying bluestone and ganister were also observed.

It is worthy of note that these investigations disclosed a condition of excessive waste in many sandstone regions, the proportion of waste in some instances reaching 75 per cent of the gross production. The gravity of this condition is intensified by the limited number of uses for which waste sandstone may be employed. The imperative need and the means of so improving quarry methods that the proportion of waste may be greatly reduced are emphasized. A study of the cause and prevention of accidents was conducted in conjunction with the efficiency and waste investigations. The result of the studies and observations made are embodied in a report now in press.

During the latter part of the fiscal year similar investigations were begun of the fluxing-limestone quarries in the vicinity of Buffalo, N. Y., and the cement-rock quarries of eastern Pennsylvania and northern New Jersey. Observations at the small number of quarries already visited indicate that the complexities involved in the quarrying of these types of stone demand careful study, and that a detailed discussion of quarry methods, particularly those relating to blasting, would be of material benefit to the industry.

Following is an excerpt from the above article:

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The following photograph is included in the article, although it does not appear to be related to the article:

Residence of John T. Pratt, New York

"At 9 and 11 East Sixty-first Street. Architect: Charles A. Platt, New York. Cut stone contractors: George Brown & Co., Newark. Built of Buff Indiana limestone."