CHARACTERISTICS OF GOOD BUILDING STONE.

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ably suffers most and sandstone least of the common building stones. Limestones, dolomitic limstones and marbles suffer comparatively little to a temperature of 900° to 1,000° F., providing they are not suddenly cooled. Above this temperature they are likely to be changed to quicklime, and slacked when exposed to moisture. The behavior of sandstones under similar tests is usually good, though sudden cooling with water seems to cause a greater degree of disintegration than in the case of limestones.

Water.—As an abrading agent, water has very little effect upon the stones in the walls of buildings. But water within the stone may be the most powerful agent of mechanical disintegration to which building stone is exposed. This water, apart from changes of temperature involving freezing, is quite unimportant as an agent of mechanical disintegration. But in freezing, water expands about 9%—100 volumes of water forming 109 volumes of ice. The force of this expansion is equal to a pressure of about one ton per square inch, and as it acts between the grains of the rock, its effect is to break the bonds holding them together and so cause crumbling. It is a severe test of the tensile strength of a rock.

But the destructive effects of freezing are not proportional to the amount of water a stone can absorb and retain. Much depends upon the character of the pores or openings containing the water, and upon the degree of saturation of the stone at the time of freezing. While rocks with very small pores retain the absorbed water longer, they take it up much more slowly and are less likely to become saturated with storm waters than are those with larger pores. All things considered, it is well to avoid stones having a high absorption ratio, and especially if they are of fine texture.

Certain rocks contain measurable quantities of readily soluble salts. In others, such salts are formed by chemical reactions between some of the constitutents of the stone and those of the atmospher. Under ordinary atmospheric conditions these salts are crystallized, dissolved, and recrystallized within the stone, and the mechanical strain accompanying the process loosens and separates the grains of the rock. This is a very important consideration in connection with the laying of foundations in alkali-rich soil. The ground water carries the salts into the stone and, when the water evaporates, they crystallize with expansion, developing a force similar to that exerted by water freezing.

Many minerals, when exposed to the action of water, become more or less hydrated. As a rule, this change involves change of volume, and as each mineral has its own ratio of expansion from hydration, and as some minerals are more likely to become hydrated than others, it is plain that the process of hydration will cause unequal stresses. The mechanical effect is similar to that of expansion from rise of temperature, but there is not the alternate expansion and contraction which accompanies temperature changes. The upper walls of a building are not likely to suffer appreciably from hydration, but the stones of the foundation may be saturated for long periods of time, and, as a result, become partially hydrated.

Mechanical Wear in Doors, Steps, etc.—Of the commoner building stones, granite and quartzite are most resistant. The wearing qualities of sandstones will depend upon the cement between the grains and the strength of the bond it affords. Those having a siliceous cement are most durable, especially if the cementing silica is united with the grains by crystal growth. Limestones are, as a rule, unsatisfactory floor and step stones, owing to their softness.

Chemical Agencies.—The principal agencies of chemical disintegration are: 1. The normal constituents of the atmosphere—nitrogen, oxygen, carbon dioxide and water vapor. 2. The impurities, or accidental constituents—ammonia, nitric, sulphurous and sulphuric acids. 3. The compounds formed by reactions between members of groups one and two, and the constituents of the stone. 4. Organic compounds derived chiefly from plant life.

Of the first group, oxygen, water and carbon dioxide are important. For convenience their work is frequently referred to under the headings: Oxidation, hydration and solution, carbonation. But it is not likely that any one of these processes would be important without one or more of the others, and it may be doubted whether, under natural conditions, any one of these goes on separately. The chemical breakdown of a rock is a very complex process, involving many reactions and interactions.

It is, perhaps, as a medium through which other chemical reagents may work, that water plays its most important part in the chemical breakdown of rocks. From the air it gathers oxygen, carbon dioxide, sulphuric and nitric acids. From the soil and disintegrating rocks it derives organic acids and mineral salts. All these are carried by it to the rocks with which it comes in contact. But this is, in part, mechanical, and in part chemical. Solution and hydration are other important phases of the work of water.

As a solvent, pure water has very little effect upon rock-making minerals, but the waters which come in contact with building stones are rarely pure. They have become dilute acids, and their solvent power is greatly increased.

Limestones and marbles, sandstones with ferruginous and calcareous cement, the feldspars and ferromagnesian minerals of granite and other igneous rocks are most readily attacked. Ordinary pure, compact, non-granular limestones are not so seriously affected. The texture prevents the acidulated waters from penetrating far into the stone before evaporation checks its course. But the porous, crystalline granular limestones and sandstones offer more favorable conditions for the work of solution. The water penetrates the intergranular spaces, dissolves or weakens the bond between the grains, and prepares the way for crumbling.

Under ordinary conditions carbon dioxide is probably the most important aid water has in its work of solution. This is due to its universal