Characteristics of Good Building Stones

By R. D. George in the Journal of Engineering.

Strength.

The strength of a stone is measured by its ability to witstand stresses. A stone in a wall is subjected to strains of various kinds. Of these, the most important are the crushing, the tensile, the transverse and the shearing stresses.

Factors determining the strength of a stone and the permanence of its strength are composition, texture, structure and mode of aggregation.

Composition.—The different minerals of which building stones may be composed vary widely in hardness and resistance to crushing force. For example, quartz is harder and has a higher crushing strength than calcite or feldspar. It is harder, but has a lower crushing strength than hornblende. Again, different minerals have different coefficients of expansion under changes of temperature; and the stresses resulting from differential expansion and contraction are more important in a rock composed of several minerals than a rock composed of only one. Some minerals, such as calcite and feldspar, have a very pronounced cleavage; while others, like quartz, have little or none. Cleavage renders a mineral weaker in certain directions than in others.

The solubility of the materials of a rock is an important factor in the permanency of its strength. This is particularly true in the matter of the cementing material in sandstones and other elastic rocks, where the weakening or removal of the bond between the grains would leave a crumbling mass.

Texture.—Other things being equal, coarse textured rocks are weaker than fine textured rocks of the same composition. There is less interlocking of the component grains, more unoccupied space, and the contact planes between the minerals are distributed in fewer directions.

Structure.—The structural feature of most importance in bulding stone is lamination. Stones are stronger and weather better when laid with their lamination planes in a horizontal position.

The crushing stress to which a stone would be subjected in the basal tier of a very high wall is far within the initial crushing strength of any stone which would be considered fit for building purposes. Almost any stone that will stand quarrying and shipment will have a crushing strength high enough for perfect safety in all ordinary structures. Builders will rarely place a stone where the direct pressure upon it will exceed one-tenth its crushing strength.

Stones in a wall are rarely subjected to direct tensile stress, but their ability to withstand transverse and shearing stresses depends largely upon their tensile strength.

Transverse stress is stress applied at right angles to the length of the block. The cracking of stone and brick walls is usually due to transverse stress resulting from unequal support throughout their length. In the cracking and separating of the two parts of a wall there is usually a component of tensile stress, but it is seldom great.

Transverse stress generally results from the settling of foundations or from the failure of the building to give the stone uniform support from end to end. As shearing is a change in the form of a mass without change of volume, it is evident that the tensile stress is an index of the shearing strength, since no change of form can take place until the cohesion of the component particles of the rock is overcome, or, in other words, until the tensile strength is exceeded.

Durability.

The durability of a stone depends chiefly upon its ability to withstand the climatic conditions to which it is exposed. The principal agencies of disintegration and decay may be divided into two classes:

(a) Mechanical, including: Temperature changes, water, wind, mechanical wear in the place where it is used.

(b) Chemical, including: Water, atmospheric gases, organic acids, etc.

Temperature Changes.—Change of volume in response to change of temperature is one of the most important causes of rock disintegration. It is more effective in crystalline rocks than in non-crystalline rocks of the same composition. The coarser the texture, the greater the strain. Rocks composed of several different minerals suffer more than those containing only one. A granite may contain quartz, feldspar and hornblende. The coefficients of expansion of these minerals are proportional to 36, 17 and 28, and as a result unequal stresses will be set up within the rock whenever expansion or contraction takes place in response to change of temperature. In a rock composed of but one mineral there is but one coefficient of cubical expansion, and the strain is more uniform. The coarser the grain of the rock, the greater the liability to disruption.

The coefficient of lineal expansion of a mineral grain is different in the direction of the different crystal axes. These unequal expansions create similarly unequal stresses in the different directions.

A porous rock will probably suffer less from this force than will a compact one of the same composition, expansion will be accommodated by the intergranular spaces. On the other hand, the area of intergranular contact is less in the porous rock, and consequently the work to be accomplished in separating the grains is less.

Stone is a poor conductor of heat, and under the influence of a midday sun the outer surface may be brought to a high temperature before the opposite side of the block has felt the effect of the sun. This causes a differential expansion which tends to weaken the stone. The north wall, not getting the direct rays of the sun, heats up more slowly and uniformly, and the resulting differential strain is much less. In winter the inside surface of a wall may have a temperature of 70° F., while the outside may be at 30°. In large fires, stone walls may become intensely heated. If water is turned on the hot stone, it splits in layers parallel to the outer surfaces. Under such conditions granite prob-

(Continued on page 22.)