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RAW MATERIALS AND MANUFACTURING PROCESSES

The quality and characteristics of masonry products are directly and exclusively determined by the raw materials and methods of manufacture used in their production. A basic introduction to this aspect of masonry will aid in understanding the finished products and how they may best be used in specific design applications.

2.1 CLAY MASONRY

Clay, the raw material from which brick, structural clay tile, and terra cotta are made, is the most plentiful natural substance used in the production of any building product. Clay is the end product of the chemical alteration over long periods of time of the less stable minerals in rock. This chemical weathering produces minute particles that are two-dimensional or flake-shaped. The unique plastic characteristics of clay soils are a result of the enormous amount of surface area inherent in this particle size and shape. The natural affinity of clay soils and moisture results in cohesiveness and plasticity from the surface tension of very thin layers of water between each of these minute particles. It is this plasticity which facilitates the molding and shaping of moist clay into usable shapes.

For the architect, the importance of understanding clay characteristics and methods of manufacture is their relationship to finished appearance and physical properties. Color depends first on the composition of the raw material and the quantitative presence of metallic oxides. Second, it is an indication of the degree of burning to which the clay has been subjected. Lighter-colored units (called salmons) for a given clay are normally associated with under-burning. They may also be indicative of high porosity and absorption along with decreased strength, durability, and resistance to abrasion. On the other hand,

the very dark colored units (called clinkers) produced from the same clay result from over-burning. This indicates that the units have been pressed and burned to a very high compressive strength and abrasion resistance, with greatly reduced absorption and increased resistance to freezing and thawing.

Most of the brick used in building construction falls between the extremes of salmon and clinker brick. Since clay composition is the primary determinant of brick color, lightness or darkness cannot be used as an absolute indicator of physical properties for brick made from different raw materials. It can, however, assist generally in the evaluation and selection of brick to meet specific design or exposure requirements.

2.1.1 Clay Composition

Clays are basically compounds of silica and alumina with varying amounts of metallic oxides and other minor ingredients and impurities. Metallic oxides act as fluxes to promote fusion at lower temperatures, influence the range of temperatures in which the material vitrifies, and give burned clay the necessary strength for structural purposes. The varying amounts of iron, calcium, and magnesium oxides also influence the color of fired clay.

Clays may be classified as either calcareous or non-calcareous. While both are hydrous aluminum silicates, the calcareous clays contain around 15% calcium carbonate, which produces a yellowish color when fired. The non-calcareous clays are influenced by feldspar and iron oxide. The oxide may range from 2 to 25% of the composition, causing the clay to burn from a buff to a pink or red color as the amount increases.

Any lime that is present in a clay must be finely crushed to eliminate large lumps. Lime becomes calcined in the burning process and later slakes or combines with water when exposed to the weather, so that any sizable fragments will expand and possibly chip or spall the brick.

2.1.2 Clay Types

There are three different types of clay which, although they are similar in chemical composition, have different physical characteristics. Surface clays, shales, and fire clays are common throughout the world, and result from slight variations in the weathering process.

Surface clay occurs quite close to the earth's surface, and has a high oxide content, ranging from 10 to 25%. Surface clays are the most accessible and easily mined, and therefore the least expensive.

Shale is a metamorphic form of clay hardened and layered under natural geologic conditions. It is very dense and harder to remove from the ground than other clays, and as a result, is more costly. Like surface clay, shale contains a relatively high percentage of oxide fluxes.

Fire clay is formed at greater depths than either surface clay or shale. It generally has fewer impurities, more uniform chemical and physical properties, and only 2 to 10% oxides. The lower percentage of oxide fluxes gives fire clay a much higher softening point than surface clay and shale, and the ability to withstand very high temperatures. This refractory quality makes fire clay best suited to producing brick and tile for furnaces, fireplaces, flue liners, ovens, and chimney stacks. The low oxide content also causes the clay to burn to a very light brown or light buff color, approaching white.