3. Natural Deformation of Rock and Stone

Most rocks were exposed to stresses in the earth’s crust in the geologic past. Such stresses cause cracking and faulting under near-surface brittle conditions, folding if more plastic, as at greater depth. The stresses are compressional, tensional or shear. The variety and combination of deformational features is almost unlimited and the basic concepts of faulting and folding are found in basic textbooks of physical geology, to which the reader is referred. This book deals with only those simple rock structures which influence the stone appearance, the stone quality and quarry operations.

3.1. Brittle Rock Fracture

Rock fracture is most significant, because it can determine the size of the stone and mining safety.

**Jointing**

A joint is a fracture in rock, generally more or less vertical, along which no appreciable movement has occurred. Joints determine the minimum size of the stone which the quarry operator can recover. Joints may be aids to the economic feasibility of hard-rock quarrying. Rock joints are ascribed to tension, extension and shear.

![Diagram of extension fracture and shear fracture](image)

**Fig. 44. Development of extension fractures and shear fractures.** Extension fractures often show plumose markings on joint surfaces, whereas shear fractures may develop slickensides by minor movements.

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shear. Fig. 44 displays the basic fracture pattern during unconfined compression of a cube or cylinder of stone or concrete. The angles between the fractures enclose almost 90°. A great complexity of multidirectional jointing in rock masses can develop from higher order shear fractures. Joints generally reflect predominant regional structural trends. Hodgson (1961) classifies joints aptly as systematic, cross joints, and predominant bedding planes (Fig. 45). Non-systematic joints are usually curved and terminate at systematic joints.

![Fig. 45. Basic joint patterns](image)

A. Planview of the relationship of systematic joints to non-systematic joints
B. Schematic block diagram showing relations between cross joints, systematic joints and bedding surfaces

From Hodgson (1961)

The joint magnitude, joint width and joint filling (with clay or crushed mineral substance) play very important roles in quarrying and quarry safety. Ornamental effects of colors and markings may occur along joints which have been filled and repaired with bright white secondary calcite or quartz. Mueller (1963) classifies large joints as an expression of geological disturbances; they may be simple joints, joint bundles, joint swarms, large joints, feather joints, and shear zones. Shear zones and feather joints indicate shear movement; such joints cut across crystals and are frequently slickensided (grooved, striated or polished) whereas tension fractures show clear, granular breaks sometimes filled with clay. Clay fillings can range from mere films to major zones.

**Colors on Joint Surfaces**

Weathering readily enters and penetrates along joints and discolors the surface with a wide range of colors of iron oxide and hydroxide. A joint surface colored or discolored in this way can contribute to a variety of colors. Interesting architectural effects of color can be obtained by properly mixing a variety of color shades on a wall (see color plate Fig. 68).

**Fabrics on Joint Surfaces**

Feather-like markings (plumes) are often found on smooth joint surfaces. The plumes diverge from a central axis and pass into a plumose (feathery) system of minor planes. Fig. 46 illustrates the basic concept after Hodgson (1961) and