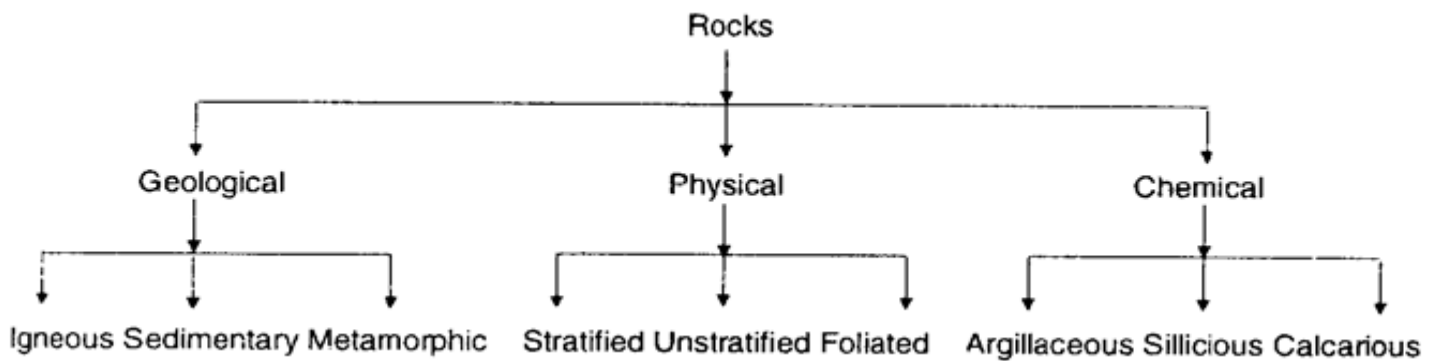


Stone

Stone has been defined as the natural, hard substance formed from minerals and earth material which are present in rocks. Rock may be defined as the portion of the earth's crust having no definite shape and structure. Almost all rocks have a definite chemical composition and are made up of minerals and organic matter. The various types of rocks from which building stones are usually derived are granite, basalt, trap, marble, slate, sandstone and limestone.

Classification of rocks

The rocks may be classified on the basis of their geological formation, physical characteristics and chemical composition as shown in Figure.



Based on geological formation

Igneous rocks: comes from volcanic origin and are formed as a result of solidification of molten mass lying below or above the earth's surface. This molten mass called *magma* is forced up as volcanic eruptions and spreads over the surface of earth where it solidifies forming basalt and trap. The classification of igneous rocks on the basis of silica content is as in Table below.

Classification of igneous rocks

Type	% of Silica	Example
Acid Rocks	70-80	Granite, rhyolite
Intermediate rocks	60-70	Syenite, andesite
Basic rocks	45-60	Gabbro and some varieties of dolerite
Ultra-basic rocks	30-45	Peridotite and some varieties of basalt and dolerite

Sedimentary rocks: The various weathering agencies, e.g. rain, sun, air, frost, etc. break up the surface of earth. Rain water carries down these broken pieces to the rivers. As the rivers descend down to the plains, the velocity decreases gradually and the sediments (disintegrated rock pieces, sand, clay, etc.) in the water settle. Due to the seasonal variation, sedimentation takes place in layers. With time, the sediments get consolidated in horizontal beds due to the pressure exerted by overlying material.

Metamorphic rocks: are formed from igneous or sedimentary rocks as a result of the action of the earth movements, temperature changes, liquid pressures, etc. The resultant mass may have a foliated structure, e.g. slate, gneiss, schist and phyllite or non-foliated structure, e.g. marble and quartzite. Examples of transformation of some of the rocks to metamorphic rocks are given in Table below.

Examples of transformation of rocks

<i>S.No.</i>	<i>Original rock</i>	<i>Metamorphic rock</i>
1.	Granite	Gneiss
2.	Syenite	Gneiss
3.	Sandstone	Quartzite
4.	Limestone	Marble, Schist
5.	Marl	Marble
6.	Shale	Slate, schist, phyllite
7.	Mudstone	Slate
8.	Dolomite	Marble
9.	Dolerite, basalt	Schist
10.	Felsite, tuff	Schist, slate
11.	Conglomerate	Gneiss, schist

Based on physical characteristics

The rocks may be classified as stratified, unstratified and foliated.

Stratified rocks: show distinct layers along which the rocks can be split. The examples are sandstone, limestone, shale, slate, marble, etc.

Unstratified rocks: do not show any stratification and cannot be easily split into thin layers. The examples of such rocks are granite, basalt, trap, etc.

Foliated rocks: have a tendency to split up only in a definite direction. Most of the metamorphic rocks have a foliated structure, except for quartzite and marble which have granulose structure.

Based on chemical characteristics

The rocks may be classified as argillaceous, siliceous and calcareous.

Argillaceous: The principal constituent is clay (Al_2O_3). The rocks are hard and brittle, e.g. slate, laterite, etc.

Siliceous: The principal constituent is silica (SiO_2), i.e. sand. The rocks are very hard and durable, e.g. granite, basalt, trap, quartzite, gneiss, syenite, etc.

Calcareous: The principal constituent is lime, e.g. limestone, marble, dolomite, etc.

Main uses of stone in civil works

- Foundation and wall items.
- Facing and architectural items.
- Building items.
- Road and rail road construction items.
- Underground structures and bridges.
- Heat and chemically resistant items.

Types of stones

1- Granite

- Igneous rock.
- Strongest and densest and takes an extremely good polish.
- Commonly used in the exterior cladding of significant buildings.
- Contains 25% to 40% quartz and 3% to 10% mica; the remainder (50% or more) is feldspar.

- Quartz is the strongest and more durable of the three minerals. It is more difficult to process (sawing, profiling, grinding).
- A granite low in quartz is generally darker in color.

The physical requirements of granite according to IQS 1387 listed in table below

Absorption %, maximum	0.4
Density kg/m^3 , minimum	2500
Minimum compressive strength N/mm^2	120
Minimum modulus of rupture N/mm^2	10

2- Limestone

- A sedimentary rock, with white to gray color.
 - Consisting primarily of the carbonates of calcium and magnesium, with small amounts of clay, sand, and organic material such as seashells and other fossils.
 - Generally non granular, with a relatively uniform surface appearance.
 - Softer than both marble and granite hence easier to quarry, saw and shape.
 - Calcium carbonate reacts with acids. Most foods contain acids therefore, limestone is not used for kitchens.
 - Used commonly for concrete aggregate.
- The Iraqi standard IQS 1387 classified the lime stone according to its density to:
 - Low density: its density higher than 1670 kg/m^3 and less than 2150 kg/m^3 .
 - Medium density: its density higher than 2150 kg/m^3 and less than 2500 kg/m^3 .
 - High density: its density higher than 2500 kg/m^3 .

3- Marble

- Geologically different from limestone because it is metamorphic rock.
- Chemically similar to limestone.

- Because of pressure and heat, marble is stronger and denser than the original limestone.
- Takes a good polish.
- Color: white to black, pink, and so on.
- Vulnerable to acid attack.

The physical requirements of marble according to IQS 1387 listed in table below

Absorption % maximum	0.75
Minimum compressive strength N/mm ²	52
Minimum modulus of rupture N/mm ²	7

4- Sandstone

- sedimentary rock
- Formed by layers of sand (quartz) particles with oxides of calcium, silicon and iron as cementing agents.
- If cemented primarily of oxide of silicon, sandstone is light in colour and strong.
- If cemented by iron oxide sandstone is brown or red in colour and softer.
- Large amount of calcium oxide makes sandstone more vulnerable to disintegration.