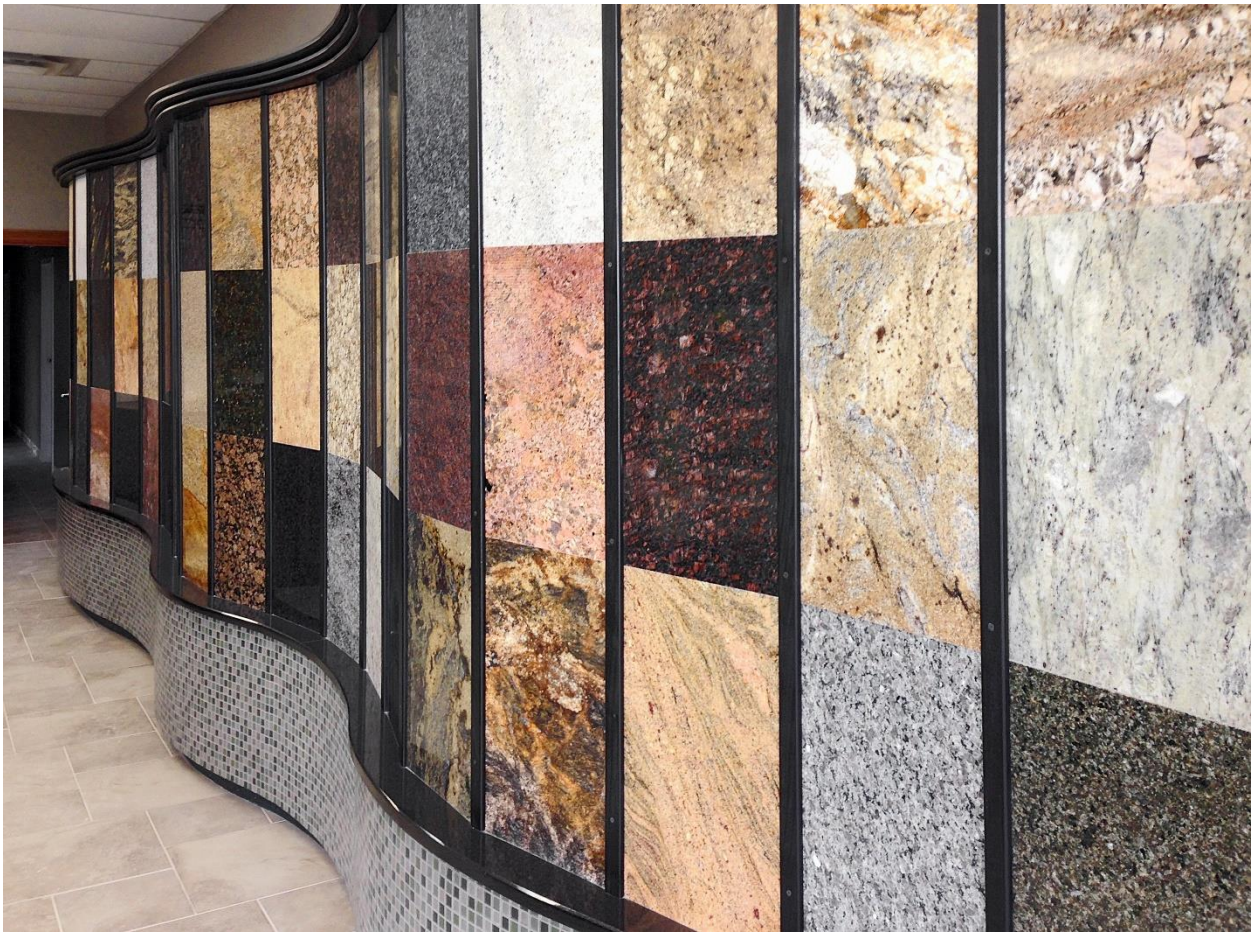
Natural Stone – The Building Material

In our history, stone had been used as a building material during the early years of civilization. Being a naturally occurring material, stone is available in the form of blocks and can be cut to required sizes and shapes when used in building.

Be it residential buildings or large palaces even temples around the world used stone as a building material.



Type of Stones

Stone is classified as geophysical, physical and chemical in civil engineering works.

Geological Classification

Stone is classified into three main groups based on their origin of formation as igneous rocks, sedimentary rocks and metamorphic rocks.

Igneous Rocks – are formed from cooling and solidifying of molten materials. Igneous rocks are strong and durable like granite and basalt. Granite stone have crystalline surface because of the

slow cooling of lava under thick cover at the top of the surface of the earth. When the cooling of lava on top of the surface of the earth results to non – crystalline and glassy texture, basalt are formed.

Sedimentary Rocks – are formed from deposits of eroded and pre – existing rock that settle in layers on sea beds. These deposits merge together by pressure and heat. Chemical agents contributes to the cementing of these deposits. Thus, rocks formed are more uniformed, fine grained and compact in nature. Sandstone and limestone are examples of these type of stone.

Metamorphic Rocks – are formed when igneous and sedimentary rocks go through metamorphic changes because of pressure and internal heat. Granite becomes gneiss and basalt and trap change to schist and laterite, limestone to marble, sandstone to quartzite and mudstone becomes slate because of metamorphic action.

Physical Classification

Rocks can be classified based on their structure.

Stratified rocks – are rocks that have layered in structure and possess planes and stratification or cleavage. They are easily split near these planes. Examples are sandstones, limestones and slate.

Unstratified Rocks – are not layered or stratified in structure. They cannot be split into thin slabs and possess crystalline and compact grains like granite and marble.

Foliated Rocks – are rocks that have a tendency to split along a definite direction only and needs to be parallel to each other just like in stratified rocks. This is very common among metamorphic rocks.

Chemical Classification

Engineers prefer to classify rocks based on their chemical composition as siliceous, argillaceous and calcareous.

Siliceous Rocks – main chemical content is silica. They are hard and durable. Granite and sandstones are examples of these rocks.

Argillaceous Rocks – the main component of these rocks is argil that is clay. These stones are hard and durable but are brittle in nature and unable to withstand shock. Examples are slate and laterite.

Calcareous Rocks – the main component of these rocks is calcium carbonate ($CaCO_3$). Examples are limestone that is of sedimentary origin and marble of metamorphic origin.

Properties of Stones

When selecting stone for engineering works, stonemasons and builders should take a deeper look on the properties of stones.

- **Structure:** Stones may be stratified or unstratified. Structured stones should be easily dressed and should be suitable when creating a super structure. Unlike unstratified stone which are hard and difficult to dress and are preferred for foundation works.

- **Texture:** Fined grained stones look attractive and mostly used in carving. They have a homogenous distribution and usually strong and durable.

- **Density:** Denser and compact stones are stronger while light weight ones are weaker. Stones with a specific gravity of 2.4 or less are considered unsuitable for buildings.

- **Appearance:** Stones with uniform and attractive colour are durable if their grains are compact. Marble and granite are great in appearance when polished and are mostly used for facades, floors and benches.

- **Strength:** It is important to look into the strength of stone before selecting it as a building block specifically their crushing strength to make sure that they can be safely used.

- **Hardness**: Stone's hardness is a very important especially when considering to use it as a flooring and pavement. Testing the stone's hardness using the Dory's testing machine is one way of finding the coefficient of hardness. Coefficient of hardness for road works should be at least 17 and it should not be less than 14 when it is to be used on building works.

- **Percentage Wear:** This is an essential property of stone that can be measured by attrition test. This is to be considered when selecting aggregate for road works and railway ballast. A good stone must not show wear of more than 2%.

- **Porosity and Absorption:** All stones absorb water because pores and capillaries are found in all stones. To test the percentage of water absorption by a stone, an absorption test should be performed by immersing the stone under water for 24 hours. The percentage of absorption alone will be a great indicator on how porous the stone is. This can be measured and compared using weight by weight method.

- **Weathering:** The good appearance of stones can be lost with rain, wind and all other external factors. Stones that have good weather resistance should be used for facade works.

- **Toughness:** A stone's resistance to impact is called toughness. Toughness is determined by performing an impact test. For road works, toughness index that is more than 19 is preferred. 13 to 19 toughness indexes are considered medium tough and less than 13 toughness index is a poor stone.

- **Resistance:** Argillaceous materials are poor in strength but they are very good in resisting fire. Sandstone resist fire better.

- **Ease of Finishing:** The cost of finishing plays an important role when it comes to the cost of stone masonry to a very great extent. An engineer should consider sufficient strength rather than high strength when selecting stone for building works because it's finishing is easy with lesser strength.

- **Seasoning:** The process of removing moisture from pores is called seasoning. Stones obtained from quarry contain moisture in the pores. If this moisture is removed, the stone's strength is improved. Allowing the stone to the action of nature for 6 to 12 months is the best way of seasoning. Laterite stones require seasoning the most.

Requirements of Good Building Stones

In order to know that a stone is good for building there are requirements that should be considered.

Strength: Although most stone are having a good strength it should still be able to resist the load coming onto it. It is also necessary to check on the strength of the stone when it comes to large structures.

Durability: A stone's durability can be see if it is capable of resisting adverse effects of natural forces like wind, rain and heat.

Hardness: This is seen when a stone is used in floors and pavements. A good stone should be able to resist abrasive factors like movement of men and materials placed over them.

Toughness: Stones for building should be really tough to withstand stress like vibrations. Vibrations may be caused by machineries or loads that are moving over them. Stone aggregates used in road construction should be tough.

Specific Gravity: A good building stone should have a specific gravity between 2.4 and 2.8. For the construction of dams, retaining walls, docks and harbours heavier variety of stones should be used.

Porosity and Absorption: A good building stone should not be porous. Porous stones allows rainwater to enter into it that causes the stone to get weak and crumble. When water freezes inside the pores like in higher altitudes, it disintegrates the stone. This phenomenon is called freeze-thaw.

Finishing: Finishing is when you give a stone its required shape | surface finish and to reduce the cost of finishing, a stone should be easy to work with to an extend. Care should also be taken when processing stone so it may not affect the required strength and durability.

Appearance: Appearance is very important especially for facade works. The colour and the ability of the stone to be polish plays an essential role in the stone's appearance.

Seasoning: A good building stone must be free from quarry sap. Laterite stones must not be used for 6 to 12 months after being quarried. They are allowed to get rid of quarry sap through the action of nature. Seasoning is the process of removing quarry sap.

Cost: One of the important requirements in selecting a building material is the cost. Cost can be lowered if the building site is near the quarry. This can bring down the cost on transportation and may also bring down the cost of the stone. Although not all good building stone can meet all the requirements because one may contradict the other. Strength and durability for example may contradict the processing requirement. What is important is that engineers should look into the properties needed for the intended work when selecting the stone.

To make sure of the properties required in stones builders and contractors can conduct different tests like crushing strength test, water absorption test, abrasion test, impact test and acid test.

Uses of Stones

Stones are used in different engineering constructions:

- For the construction of foundations, walls, columns and arches in stone masonry.
- For flooring, walls, benches, vanities, fireplaces, etc..
- Stone slabs for damp proof courses, lintels and as roofing materials.
- Stones with good appearance for facade works of buildings like polished marble and granite.
- For paving roads, footpaths and open spaces around the buildings.
- For construction of piers and abutments of bridges and dams.
- Crushed stones for providing base course for roads and they form a finishing coat when mixed with tar. They are also used as inert material in concrete, for making artificial stones and building blocks and as railway ballast.

Common Building Stones

The most common building stones are basalt, granite, sandstone, slate, laterite, marble, gneiss, limestone and quartzite.

Basalt - is an igneous rocks and are used as road metals and aggregates for concrete. They are also used as pavement and for rubble masonry work for bridge piers, river walls and dams.

Granite – is an igneous rock and is used for monumental and institutional buildings. Polished granite is used as bench tops, cladding for columns and wall. They are also used as coarse aggregates in concrete.

Sandstone – is a sedimentary rock and is therefore stratified. It is desirable to use it with silica cement for heavy duty structures. It is also used for masonry work for dams, bridge piers and river walls.

Slate – is a metamorphic rock and is used for roofing tiles, slabs and pavements.

Laterite – is a metamorphic rock and is used as a building stone.

Marble – is a metamorphic rock and is used for facades and ornamental works. It is also used for columns, flooring, steps and as table top.

Gneiss – is a metamorphic rock and is used in minor constructions. The hard variety can be used for buildings.

Quartzite – is a metamorphic rock and are uses as building blocks and slabs. They used also as aggregates for concrete.