Building Stones

Building Construction Material

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Definition

- **Stones are naturally occurring compact, solid and massive material that make the crust of the earth.**
- **Technically, the stones are called as rocks.** The rocks occur in great variety. The rocks posses suitable properties often find use in building stones. **It follows that all building stones are rocks in nature, all rocks may not be useful as building stones.**

Introduction

- **Stones have been used in all type of construction since time immemorial.** *The pyramids of Egypt, The eiffel tower, The temple of Jagannathpuri, the Taj Mahal, the red fort, the great wall of china and hundreds of historical buildings in each big country are made of stones. The greatest thing about stone is that they are natural and do not required to be manufactured.*
- **Stone, timber and clay had been the most commonly construction used material right from the beginning of the civilization till the advent of Portland cement and hence concrete in the early nineteenth century.**

Some Historical Buildings

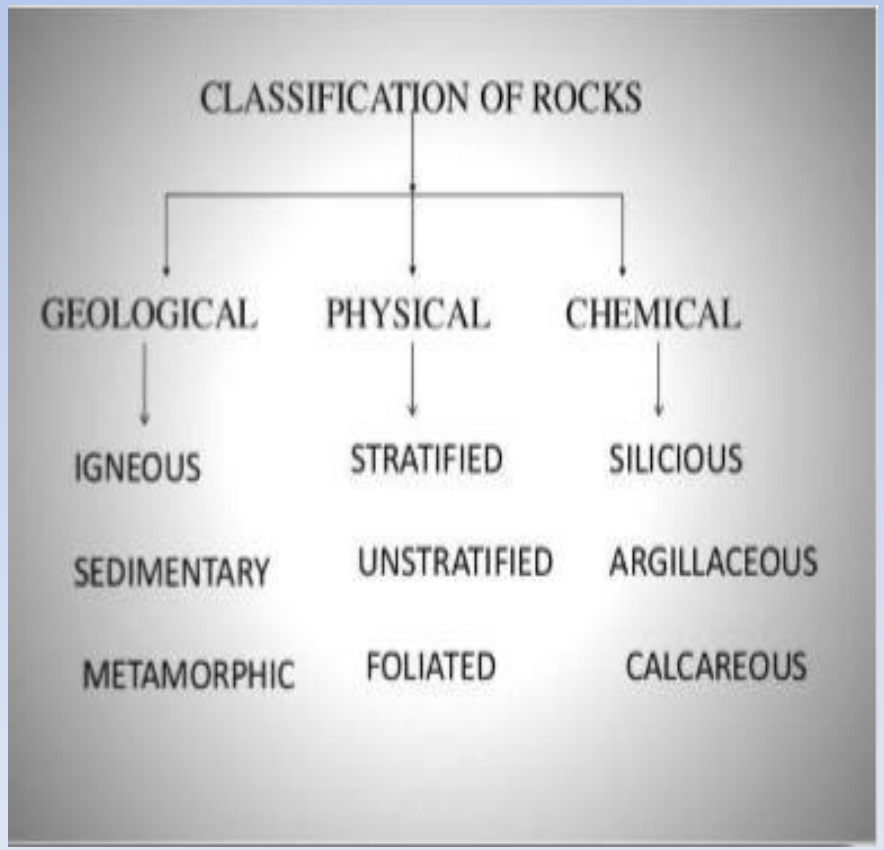
Sources of Stones

- The stones are obtained from rocks. A rock represents a definite portion of earth's surface. It is not homogeneous. It has no definite chemical composition and shape. It is known as mono-mineralic rock, if it contains only one mineral and it is known as poly-mineralic rock, if it contains several minerals. The quartz, sand, chemically pure gypsum, magnesite, etc., are examples of mono mineralic rocks and basalt, granite etc., are examples of the poly mineralic rocks. The properties of a rock are governed by the properties of minerals present in its structure.

Classification of Rocks

The building stones are obtained from the rocks which are classified in the following three ways

1. Geological Classification
2. Physical Classification
3. Chemical Classification



Geological Classification

According to this classification, the rocks are of the following *three* types :

1. Igneous rocks
2. Sedimentary rocks and
3. Metamorphic Rocks

1) **Igneous Rocks :** The inside portion of the earth's surface has high temperature so as to cause *fusion* by heat at even ordinary pressures. The molten or pasty rocky material is known as the *magma* and this magma occasionally tries to come out to the earth's surface through cracks or weak portions. The rocks which are formed by the cooling of magma are known as the *igneous rocks*.

[Ignis = Fire]

Igneous Rocks

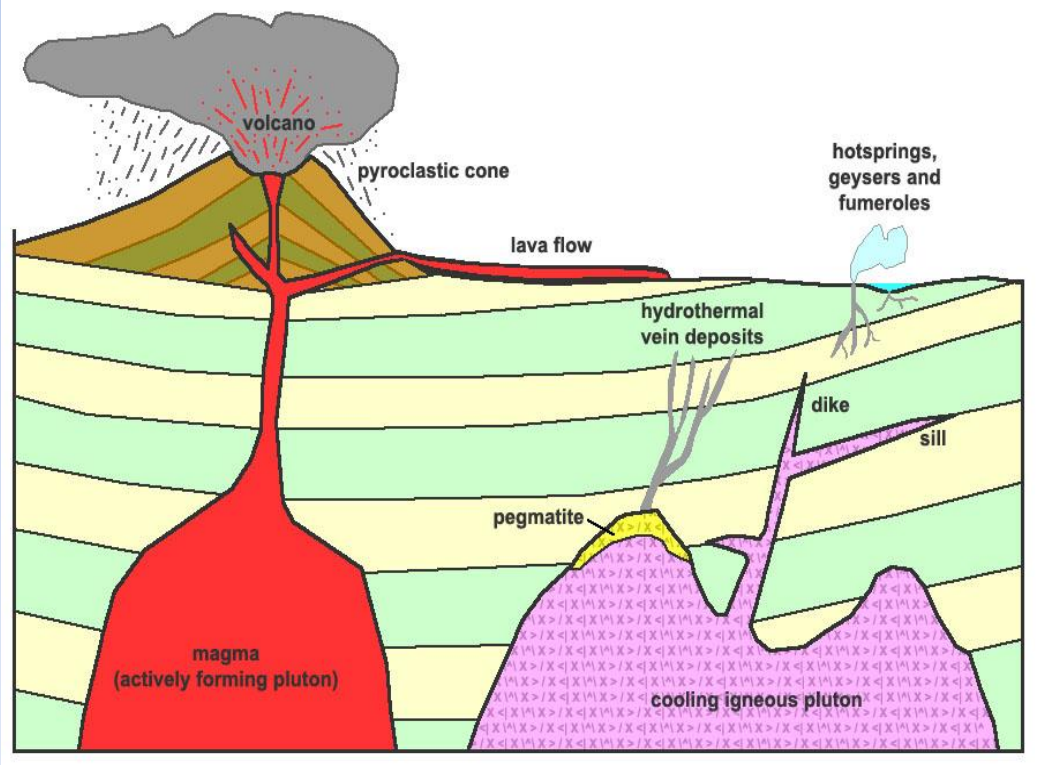
The igneous rocks are recognized in the following three classes :

(a) ***Plutonic Rocks*** : Such rocks are formed due to cooling of magma at a considerable depth from earth's surface. The cooling is slow and the rocks posses coarsely grained crystalline structure. The igneous rocks commonly used in building industry are of plutonic type. The ***granite*** is the leading example of this type of rock.

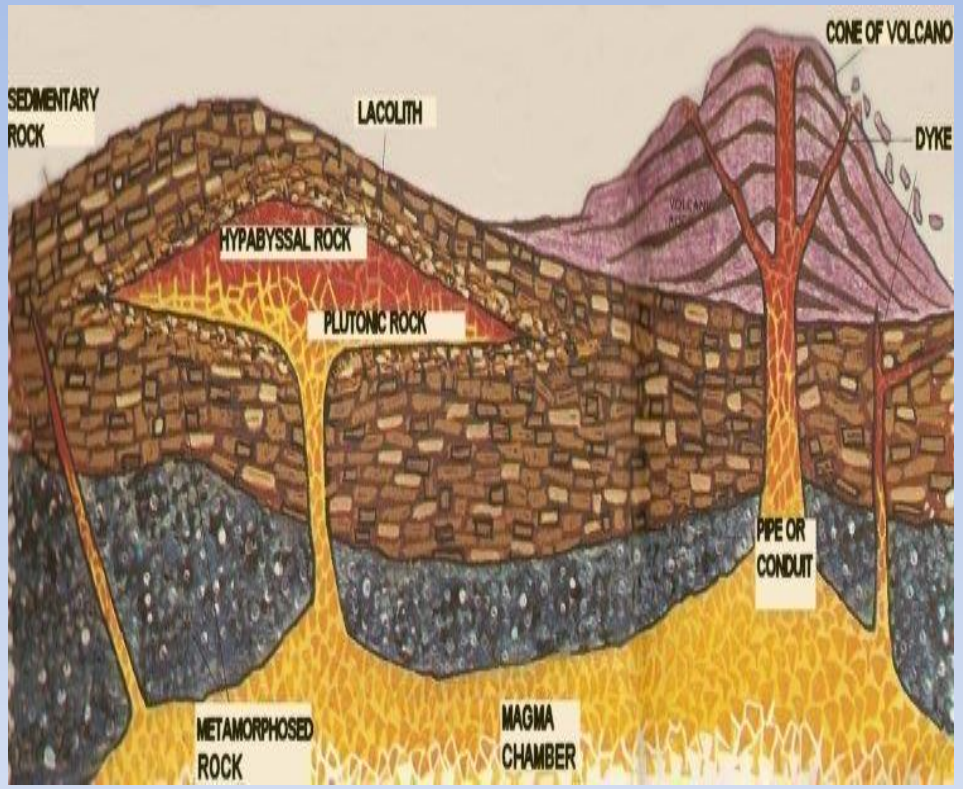
(b) ***Hypabyssal Rocks*** : Such rocks are formed due to cooling of magma at a relatively shallow depth from the earth's surface. The cooling is quick and hence these rocks posses finely grained crystalline structure. The ***dolerite*** is an example of this type of rock.

(c) ***Volcanic Rocks*** : Such rocks are formed due to pouring of magma at earth's surface. The cooling is very rapid as compared to the previous two cases. Hence these rocks are extremely fine grained in structure. They frequently contain some quantity of glass which is a non – crystalline material. The ***basalt*** is an example of this type of rock.

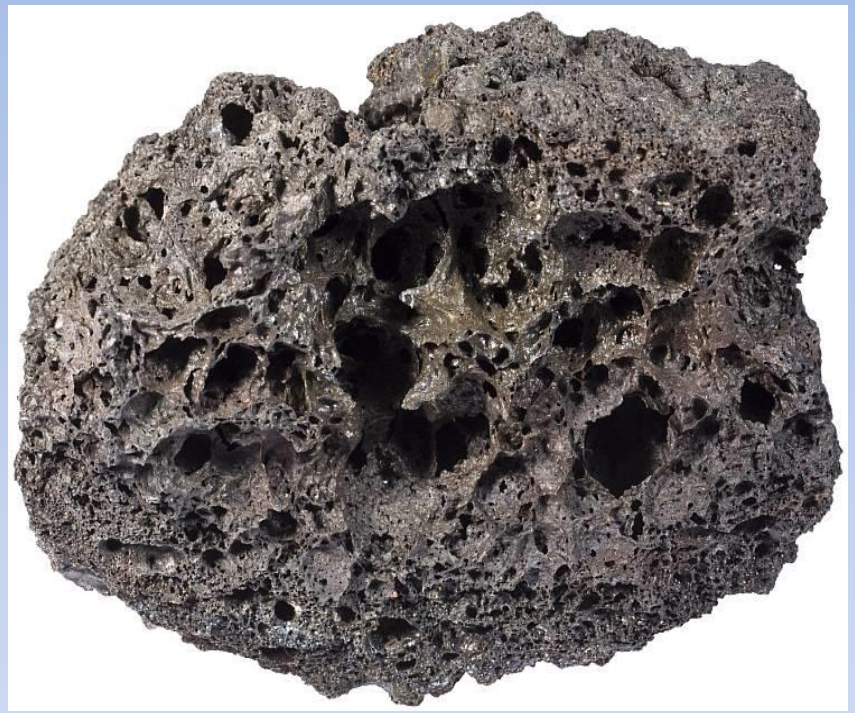
Plutonic Rocks

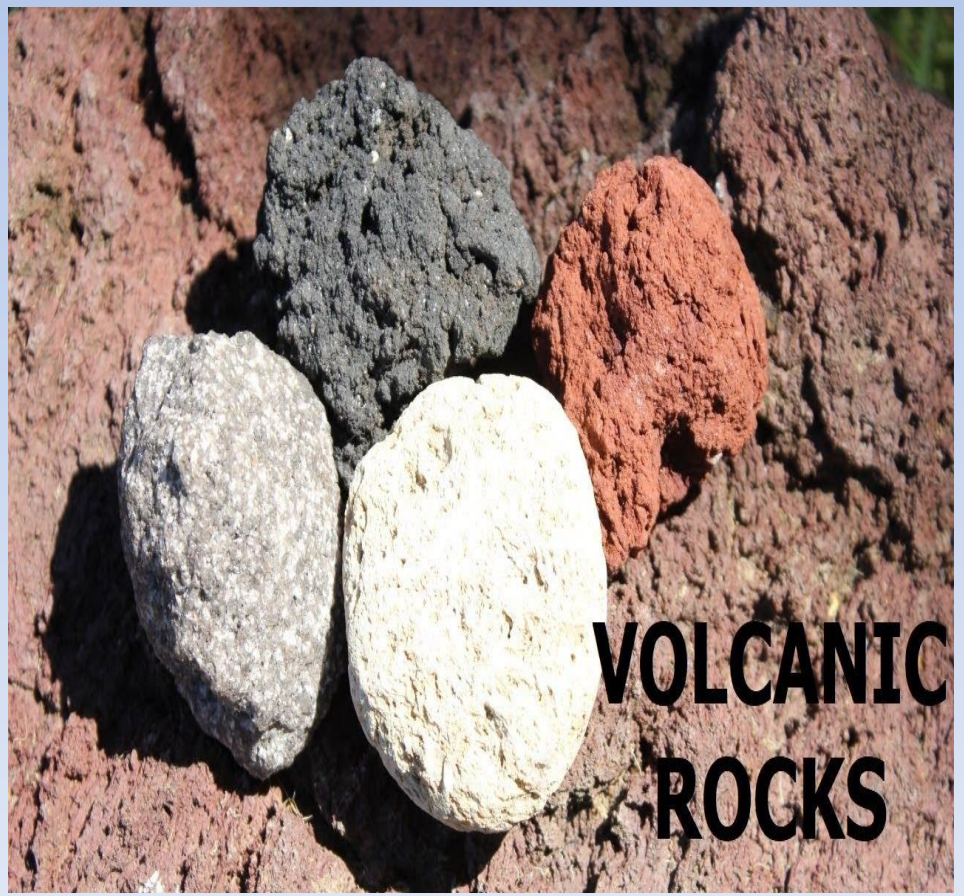


Hypabyssal Rocks



Volcanic Rocks





2) **Sedimentary Rocks :** These rocks are formed by the deposition of products of weathering on the pre – existing rocks. All the products of weathering are ultimately carried away from their place of origin by the agents of transport. Such agents are frost, rain, wind, flowing water, etc., Following four types of deposits occur :

(a) Residual Deposits : Some portion of the products of weathering remain at the site of origin. Such a deposit is known as a *residual deposit.*

(b) Sedimentary Deposits : The insoluble products of weathering are carried away in suspension and when such products are deposited, they give rise to the *sedimentary deposits.*

(c) Chemical Deposits : Some material that is carried away in solution may be deposited by some physio – chemical processes such as evaporation, precipitation, etc., It gives rise to the *chemical deposits*.

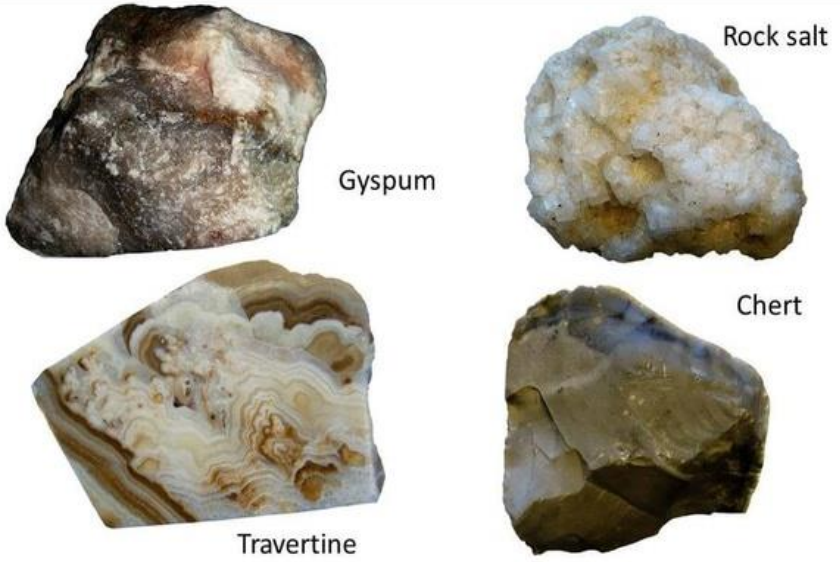
(d) Organic Deposits : Some portion of the product of weathering gets deposited through the agency of organisms. Such deposits are known as the *organic deposits.*

Examples of sedimentary rocks are gravel, sandstone, limestone, gypsum, Lignite etc.,

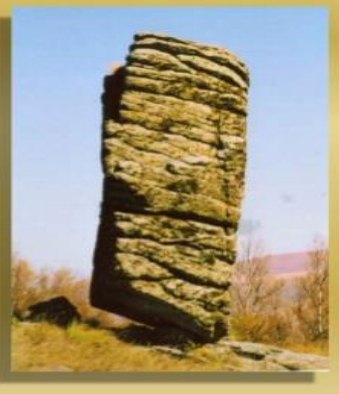
(Sediment = Particle)

Sedimentary Rocks

Chemical sedimentary rocks



Residual Rocks.



3) Metamorphic Rocks : [Meta = Change; Morph = Form]

- These rocks are formed by the change in character of the pre – existing rocks. The igneous as well as sedimentary rocks are changed in character when they are subject to great heat and pressure. The process of change is known as *metamorphism*.

- The mineral composition and texture of a rock represent a system which is in equilibrium with its physio – chemical surroundings. The increase of temperature and pressure upsets this equilibrium and metamorphism results from an effort to re – establish a new equilibrium.
- The changed minerals under changed conditions are arranged in a manner which is more suitable to the new environments. It should however be noted that changes produced by weathering and sedimentation are not included in the metamorphism.
- There are three agents of metamorphism, namely, heat, pressure and chemically acting fluids.

Four types of metamorphism occur with various combinations of heat, uniform pressure and directed pressure :

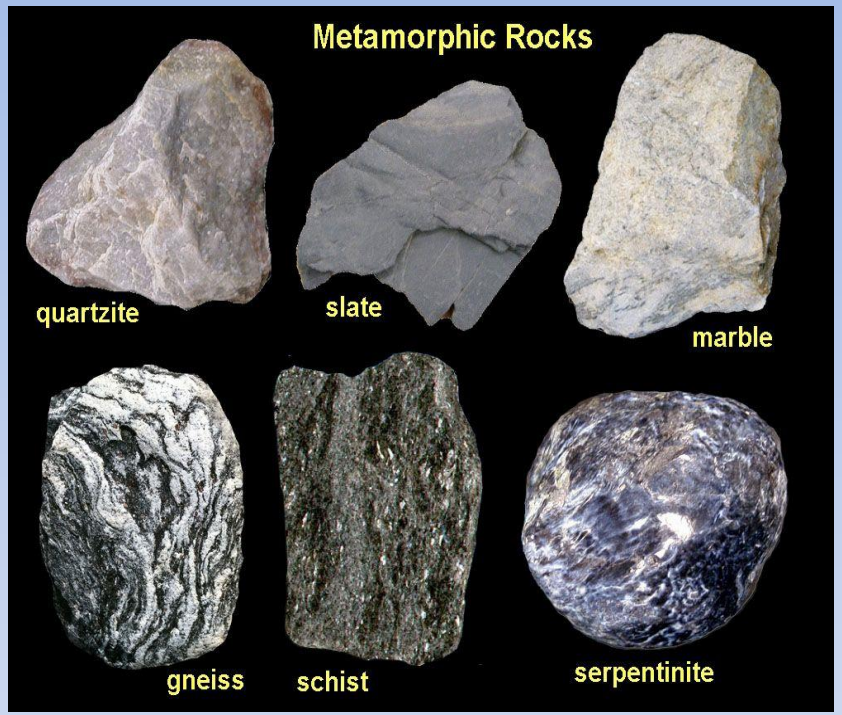
(a) ***Thermal Metamorphism :*** The heat is the predominant factor in this type of metamorphism.

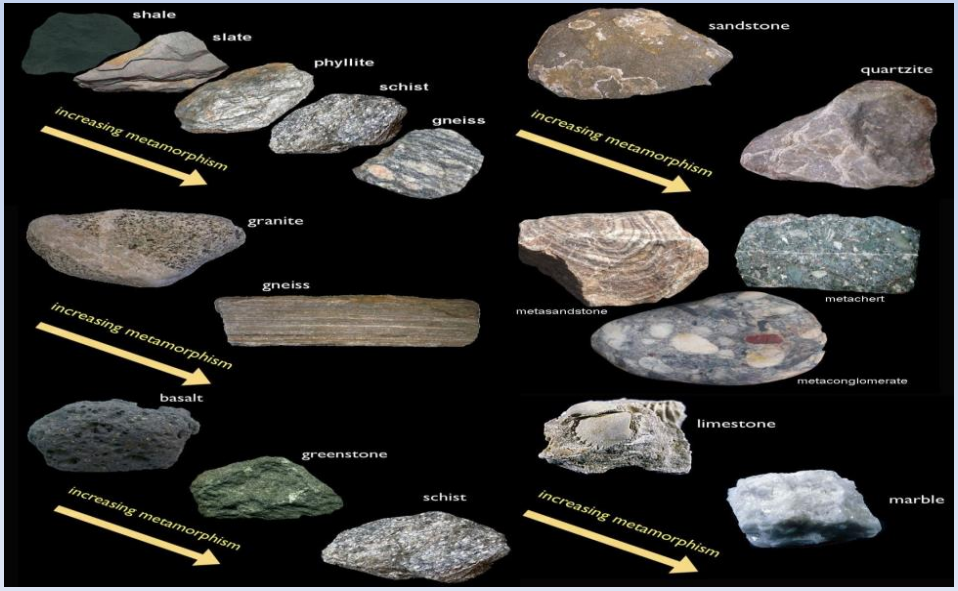
(b) ***Cataclastic metamorphism :*** At the surface of the earth, the temperatures are low and metamorphism is brought about by directed pressure(Non – uniform pressure) only. Such metamorphism is known as *cataclastic metamorphism.*

(c) ***Dynamo – thermal metamorphism :*** There is a rise in temperature with increase in depth. Hence, the heat in combination with stress(directed pressure), brings about the changes in rock. Such metamorphism is known as the *dynamo – thermal metamorphism*.

(d) ***Plutonic metamorphism :*** The stress is effective only up to a certain depth. This is due to the fact that rocks become plastic in nature at certain depths. At great depths, a stage is reached when stress cannot exist as it is converted into uniform pressure because of the plasticity of rocks. The metamorphic changes at great depths are therefore brought about by uniform pressure and heat. Such metamorphism is known as the *plutonic metamorphism*.

Metamorphic Rocks





Physical Classification

This classification is based on general structure of rocks. According to this classification, the rocks are of the following three types :

i. ***Stratified Rocks :***These rocks possess planes of stratification or cleavage and such rocks can easily be split up along these planes. The sedimentary rocks are distinctly stratified rocks.

ii. ***Un stratified Rocks*** : These rocks are un stratified. The structure may be crystalline granular or compact granular. The igneous rocks of volcanic agency and sedimentary rocks affected by movement of the earth are of this type of rocks.

iii. ***Foliated rocks*** : These rocks have a tendency to be split up in a definite direction only. The foliated structure is very common in case of metamorphic rocks.

Stratified Rocks

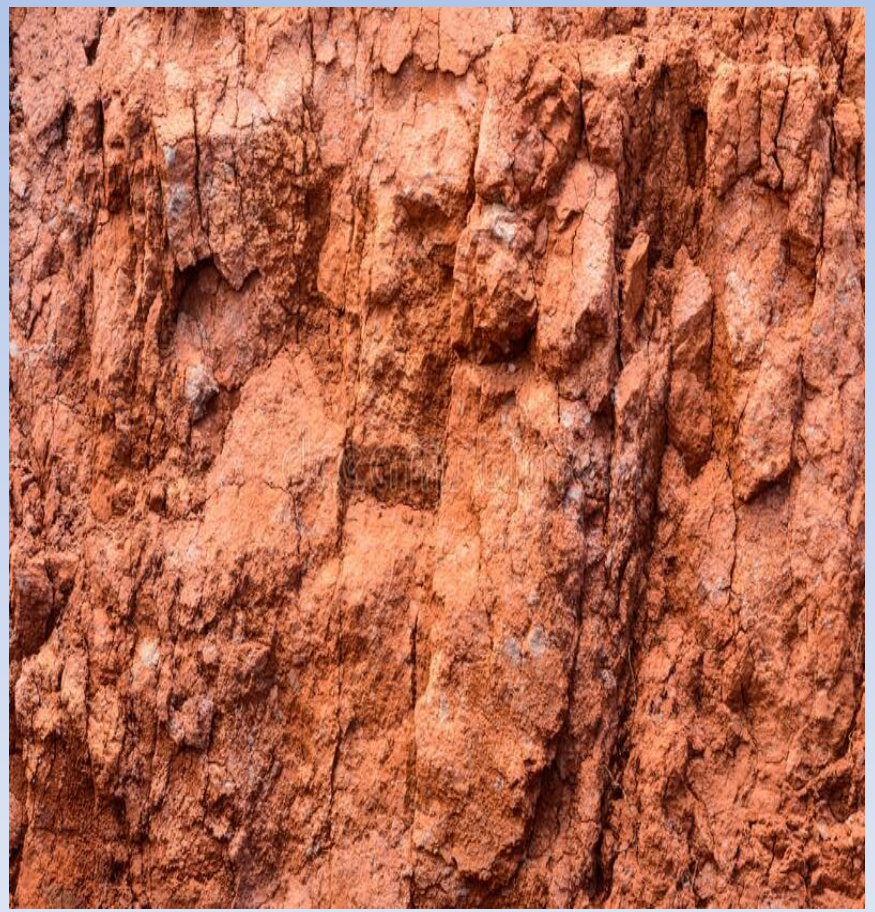
Un Stratified Rocks

Chemical Classification

- This classification is known as the scientific or engineering classification and according to this classification, the rocks are of the following three types.

A. Siliceous rocks : In these rocks, the silica predominates. The rocks are hard and durable. They are not easily affected by the weathering agencies. The silica however in combination with weaker minerals may disintegrate easily. It is therefore necessary that these rocks should contain maximum amount of free silica for making them hard and durable. The granites, quartzites, etc., are examples of siliceous rocks.

B. Argillaceous Rocks : In these rocks, the argil or clay predominates. Such rocks may be dense and compact or they may be soft. These stones are hard and durable but brittle. The slates, laterites, etc., are examples of the argillaceous rocks.



C. *Calcareous Rocks :* In these rocks, the calcium carbonate predominates. The durability of these rocks will depend upon the constituents present in the surrounding atmosphere. The limestones, marbles, etc., are examples of calcareous rocks.

USES OF STONES

The stones are used in the construction of buildings from the ancient times and most of the ancient temples and forts of our country were built with stones. Even at present, they form a basic material for cement concrete and bricks.

Following are the various uses to which stones are employed :

(1) Structure : The stones are used for foundations, walls, columns, lintels, arches, roofs, floors, damp – roof courses etc.,

(2) Face – work : The stones are adopted to give massive appearance to the structure. The walls are of bricks and facing is done in stones of desired shades. This is known as the composite masonry.

(3) Paving : The stones are used to cover floor of buildings of various types such as residential, commercial, industrial, etc., They are also adopted to form paving of roads, footpaths, etc.,

(4) Basic Material : The stones are disintegrated and converted to form a basic material for cement concrete, murum of roads, calcareous cements, artificial stones, hollow blocks, etc.,

(5) Miscellaneous : In addition to above uses, the stones are also used as:

- Ballast for railways
- Flux in blast furnaces
- Blocks in the construction of bridges, piers, abutments, retaining walls, light houses, dams, etc.,

It should however be remembered that the stones are gradually losing their popularity as the building material because of the following facts :

i. The dressing of stones proves to be tedious, laborious and time – consuming.

ii. The stones of desired strength and quality are not easily available at moderate rated, especially in plain areas.

iii. The alternatives to stones, namely R.C.C. And steel, have proved to be stronger, less bulky, more durable and more suitable for present day construction of multi – storeyed and important buildings.

iv. The structures constructed of stones cannot be rationally designed as in case of R.C.C. Or steel structures.

Tests For Stones

- The building stones are to be tested for their different properties. Following are such tests for the stones :

(1) Acid Test
(2) Attrition Test
(3) Crushing Test
(4) Crystallization Test
(5) Freezing and thawing Test
(6) Hardness Test
(7) Impact Test
(8) Microscopic Test
(9) Smith’ s Test
(10) Water absorption Test

(1) Acid Test : In this test, a sample of stone weighing about 0.5 to 1 N is taken.

- It is placed in a solution of hydrochloric acid having strength of one percent and it is kept there for seven days.
- The solution is agitated at intervals.
- A good building stone maintains its sharp edges and keeps its surface free from powder at the end of this period.
- If edges are broken and powder is formed on the surface, it indicates the presence of calcium carbonate and such a stone will have poor weathering quality.
- It is natural that this test cannot be applied to the limestones. This test is usually carried out on the sandstones.

(2) Attrition Test : This test is done to find out the rate of wear of stones which are used in road construction. The results of test indicates the resisting power of stones against the grinding action under traffic.

Following procedure is adopted :

i. The sample of stones is broken into pieces of about 60 mm size.

ii. Such pieces, weighing 50 N are put in both the cylinders of Deval's attrition test machine. The diameter and length of cylinder are respectively 200 mm and 340 mm.

iii. The cylinders are closed. Their axes make an angle of 30 degrees with the horizontal.

iv. The cylinders are rotated about horizontal axis for 5 hours at the rate of 30 R.P.M.

v. After this period, the contents are taken out from the cylinders and they are passed through a sieve of 1.5 mm mesh.

vi. The quantity of material which is retained on the sieve is weighed.

vii. The percentage wear is worked out as follows :

Percentage wear = (Loss in weight / Initial Weight) X 100

Test on stones

MFA
Civil Eng.

1) Acid test

->

HCL or H2SO4

3days --->

Test on stones

MFA
Civil Eng.

9) Attrition test

2000 r.p.m

-->

% of wear=(W1 - W2) *100/W1

(3) Crushing Test : The compressive strength of stone is found out with the help of this test.

- The sample of stone is cut into cubes of size 40 mm X 40 mm X 40 mm. The sides of cubes are finely dressed and finished.
- The minimum number of specimens to be tested is three. Such specimens should be placed in water for about 72 hours prior to test and thereafter tested in saturated conditions.
- The load – bearing surface is then covered with plaster of Paris or 5 mm thick plywood. The load is applied axially on the cube in a crushing test machine.
- The rate of loading is 13.72 N/mm2 per minute. The crushing strength of the stone per unit area is the maximum load at which its sample crushes or fails divided by the area of the bearing face of the specimen.

(4) Crystallisation Test : In this test, at least four cubes of stone with side as 40 mm are taken. They are dried for 72 hours and weighed.

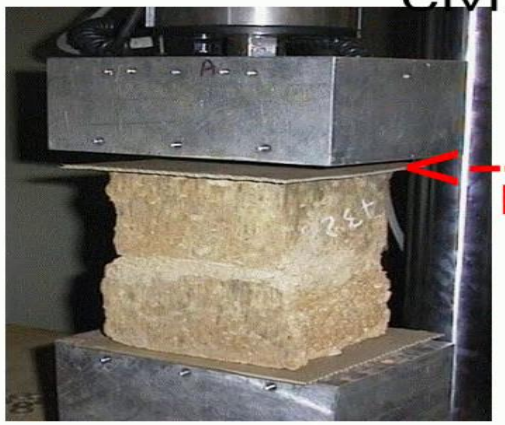
- They are then immersed in 14% solution of Na_2SO_4 for 2 hours. They are dried at 100^0 C and weighed. The difference in weight is noted.
- This procedure of drying, weighing, immersing and reweighing is repeated at least five times. Each time, the change in weight is noted and it is expressed as a percentage of original weight.
- It is to be noted that the crystallisation of $CaSO_4$ in pores of stones causes the decay of stone due to weathering. But, as $CaSO_4$ has low solubility in water, it is not adopted in this test.

Test on stones

MFA
Civil Eng.

2) Crushing test

side 40mm



5mm
plywood

Test on stones

MFA
Civil Eng.

3) Cristallization test

side 40mm

100°C

40% of Na2SO4

(5) Freezing and Thawing Test :

- The specimen of stone is kept immersed in water for 24 hours.
- It is then placed in a freezing mixture at -12^0 C for 24 hours.
- It is then thawed or warmed at atmospheric temperature.
- This should be done in shade to prevent any effect due to wind, sun rays, rain etc., Such a procedure is repeated several times and behaviour of stone is carefully observed.

(6) Hardness Test :"Hardness of stone may be defined as its capacity to resist scratching or abrasion "

To determine the hardness of a stone, the test is carried out as follows :

i. A cylinder of diameter 25 mm and height 25 mm is taken out from the sample of stone. It is weighed.

ii. It is placed in Dorry's testing machine and passed with a pressure of 12.50 N.

iii. The annular steel disc of machine is then rotated at a speed of 28 R.P.M.

iv. During the rotation of disc, the coarse sand of standard specification is sprinkled on the top of disc.

v. After 1000 revolutions, the specimen is taken out and weighed.

vi. The coefficient of hardness is found out as

Coefficient of hardness = 20 – [Loss in weight in gm/3]

Test on stones

MFA
Civil Eng.

10) Freezing and thawing test

---> 24Hour

Test on stones

MFA
Civil Eng.

4) Hardness test

Dia 25mm
Hei 25mm

--> 

28 r.p.m

1000 rotation ---> 

Coeff. of hard=20-LIW(gm) /3

(7) Impact Test : " It is a capacity of the stone to resist impact loads "

To determine toughness of a stone, the impact test is carried out in page impact machine as follows :

(i) A cylinder of diameter 25 mm and height 25 mm is taen out from the sample of stone.

(ii) It is placed on cast – iron anvil of machine.

(iii) A steel hammer of weight 20 N is allowed to fall axially in a vertical direction over the specimen.

(iv) The height of first blow is 1 cm; that of second blow is 2 cm; that of third blow is 3 cm; and so on.

(v) The blow at which specimen breaks is noted. If it is nth blow, n represents the toughness index of stone.

(8) Microscopic Test : In this test, the sample of stone is subjected to the microscopic examination. The thin sections of stone are taken and placed under the microscope to study various properties such as :

Average grain size; Existence of pores, Fissures, Veins and Shakes; Mineral constituents; Nature of cementing materials; Presence of any harmful substance; Texture of stone etc.,

Test on stones

MFA
Civil Eng.

7) Impact test

+

->

Test on stones

MFA
Civil Eng.

8) Microscopic test

(9) Smith's Test : This test is performed to find out the presence of soluble matter in a sample of stone. The few chips or pieces of stones are taken and they are placed in a glass tube. This tube is then filled with clear water. After about an hour, the tube is vigorously stirred or shaken. The presence of earthy matter will convert the clear water into dirty water. If water remains clear, the stone will be durable and free from any soluble matter. On the other hand, if the water becomes dirty, it will indicate that the stone contains too much of soluble earthy and mineral matters.

(10) Water Absorption Test : Following procedure is adopted for this test :

i. From the given sample of stone, a cube weighing about 0.50 N is prepared. Its actual weight is recorded. Let it be W_1 N.

ii. The cube is then immersed in distilled water for a period of 24 hours.

iii. The cube is taken out of water and surface water is wiped off with a damp cloth.

iv. It is weighed again. Let its weight be W_2 N.

v. The cube is suspended freely in water and its weight is recorded. Let it be W_3 N.

vi. The water is boiled and cube is kept in boiling water for five hours.

vii. It is then removed and surface water is wiped off with a damp cloth. Its weight is recorded. Let it be W_4 N.

From the above data, the values of the following properties of stones are obtained :

Percentage absorption by weight after 24 hours $= \frac{W_2 - W_1}{W_1} X\ 100$

Percentage absorption by volume after 24 hours $= \frac{W_2 - W_1}{W_2 - W_3} X\ 100$

[Volume of displaced water $= W_2 - W_3$]

Percentage porosity by volume $= \frac{W_4 - W_1}{W_2 - W_3} X\ 100$

$$\text{Density} = \frac{W_1}{W_2 - W_3}\ \text{N/m}^3$$

$$\text{Specific Gravity} = \frac{W_1}{W_2 - W_3}$$

$$\text{Saturation Coefficient} = \frac{Water\ absorption}{Total\ porosity} = \frac{W_2 - W_1}{W_4 - W_1}$$

Test on stones

MFA
Civil Eng.

6) Smith's test

+

stirred -->

Test on stones

MFA
Civil Eng.

5) Water absorption test

105°C
3day

50gm
W1

3days
W2

AOF =(W2-W1) *100/W1

QUALITIES OF A GOOD BUILDING STONE

1. **Crushing Strength :**

✓ For a good structural stone, the crushing strength should be greater than 100 N/mm2. The approximate values of crushing strength of some of the stones are shown below

Rock	Stone	Crushing Strength in MPa
Igneous	Basalt	150 to 185
	Diorite	90 to 150
	Granite	75 to 127
	Syenite	90 to 150
	Trap	330 to 380
Sedimentary	Laterite	1.80 to 3.10
	Limestone	54
	Sandstone	64
	Shale	0.20 to 0.60
Metamorphic	Gneiss	206 to 370
	Slate	75 to 207

2. Appearance :

- ✓ The stones which are able to be used for face work should be decent in appearance and they should be capable of preserving their colour uniformly for a long time.
- ✓ It is desirable to prefer light coloured stones as compared to dark coloured stones because there are chances of the latter variety to be attacked easily by weathering agents.
- ✓ A good building stone should be of uniform colour and free from clay holes, spots of other colour, bands, etc.,

3. Durability : "*It denotes the period in years for which a stone may stand practically unaltered after being used in construction*".

- ✓ A durable stone must Withstand load, Must keep the original appearance ,Must resist the effect of cold and heat, Must not suffer deterioration and decomposition by gases and surrounding industries.
- ✓ A good building stone should be durable. The various factors contributing to durability of a stone are its chemical composition, texture, resistance to atmospheric and other influences, location in structure, etc.
- ✓ For making stones durable. Their natural bed should be carefully noted.
- ✓ The stones should be so arranged in a structure that the natural bed is perpendicular or nearly so to the direction of pressure.

4. Facility of dressing :

- ✓ The stones should be such that they can be easily carved, moulded, cut and dressed.
- ✓ It is an important consideration from the economic point of view.
- ✓ However this property of stone is opposed to its strength, durability and hardness.
- ✓ Hence it is to be properly correlated with respect to the situation in which stone is to be used.

7. Percentage Wear :

✓ In attrition test, if wear is more than 3%, the stone is not satisfactory.
✓ If it is equal to 3 %, the stone is just tolerable.
✓ For a good building stone, the wear should be equal to or less than 3%.

5. Fracture :

- ✓ For a good building stone, its fracture should be sharp, even, bright and clear with grains well cemented together.
- ✓ A dull, chalky and earthly fracture of a stone indicates signs of early future decay.

6. Hardness :

✓ The coefficient of hardness, as worked out in hardness test, should be greater than 17 for a stone to be used in road work.
✓ If it is between 14 and 17, the stone is said to be of medium hardness.
✓ If it is less than 14, the stone is said to be of poor hardness and such stone should not be used in road work.

8. Resistance to Fire :

- ✓ The mineral composing stone should be such that shape of stone is preserved when a fire occurs.
- ✓ The failure of stones in case of a fire is due to various reasons such as rapid rise in temperature, sudden cooling, different coefficients of linear expansions of minerals etc.,
- ✓ The free quartz suddenly expands at a temperature lower than 600^0 C.
- ✓ The limestone resists fire upto about 800^0 C and it then splits into CaO and CO_2.
- ✓ The sandstone with silicates as binding material can resist fire in a better way.
- ✓ The argillaceous stones are poor strength, but they can resist fire quite well.

9. Seasoning :

- The stones should be well seasoned before putting into use.
- The stones obtained fresh from a quarry contain some moisture which is known as the *quarry sap*.
- The presence of this moisture makes the stone soft.
- Hence the stones quarried freshly are easy to work.
- It is therefore desirable to do dressing, carving, etc., when stones contain quarry sap.
- The stones should be dried or seasoned before they are used in structural work.
- A period of about 6 to 12 months is considered to be sufficient for proper seasoning.

10. Specific Gravity :

- For a good building stone, its specific gravity should be greater than 2.7 or so.
- The heavy stones are more compact and less porous and they can be used for various engineering applications such as dams, weirs, retaining walls, docks, harbours, etc.,
- On the other hand, if stones are to be used for domes, roof covering, etc., the lighter varieties of stones are preferred.

11. Texture :

- ✓ A good building stone should have compact fine crystalline structure free from cavities, cracks or patches of soft or loose material.
- ✓ The stones with such texture are strong and durable.

12. Toughness Index :

- ➢ In impact test, if the value of toughness index comes below 13, the stone is not tough.
- ➢ If it comes between 13 and 19, the stone is said to be moderately tough.
- ➢ If it exceeds 19, the toughness of stone is said to be high.

13. Water Absorption :

- All the stones are more or less porous, but for a good stone, percentage absorption by weight after 24 hours should not exceed 0.60.
- The porous stones seriously affect the durability of stones.
- The rain water as it descends through the atmosphere absorbs some acidic gases forming light acids.
- Such rain water, if absorbed by porous stones, react with the constituents of stones causing them to crumble.
- Similarly, in cold regions, if porous stones are used, the water remaining in pores will disintegrate stones because of its increase in volume on freezing.
- Hence the porous stones should not be recommended for places subjected to frost, rain or moisture.

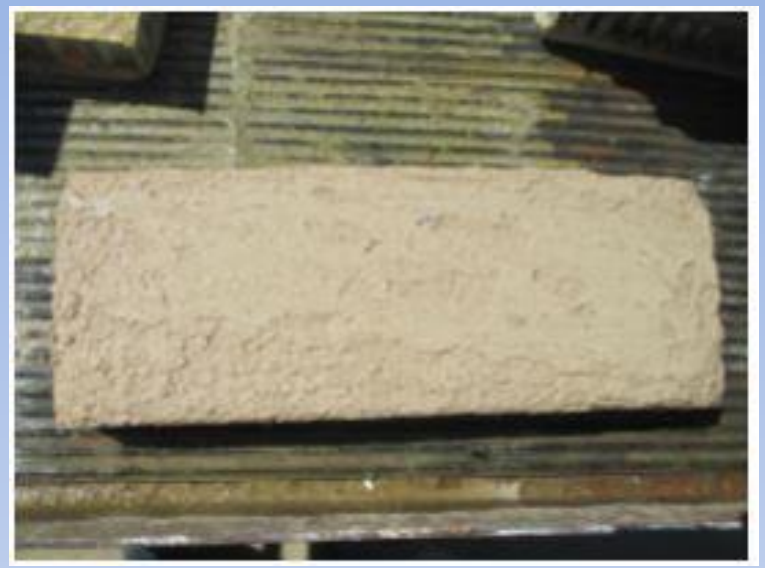
14. Weathering :

- ✓ A good building stone should possess better weathering qualities.
- ✓ It should be capable of withstanding adverse effects of various atmospheric and external agencies such as rain, frost, wind, etc.,
- ✓ The best way to know the resisting power of a stone to the action of weather is to study the performance of buildings constructed with the similar stoned in the locality or at a place having more or less similar atmospheric conditions.
- ✓ The stones having excellent weathering qualities should only be used in the construction of important buildings.

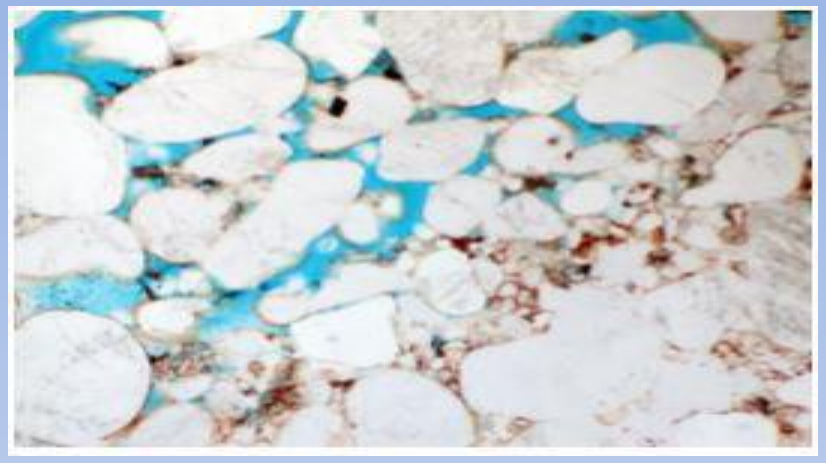
- ❖ It is therefore necessary to study carefully the situation in which stones are to be used before any recommendation is made. Other factors which affect the selection of stone are easy availability, nearness of quarry, facility of transport, reasonable price, climatic conditions of the construction site etc.,

DURABILITY ASPECTS OF STONES

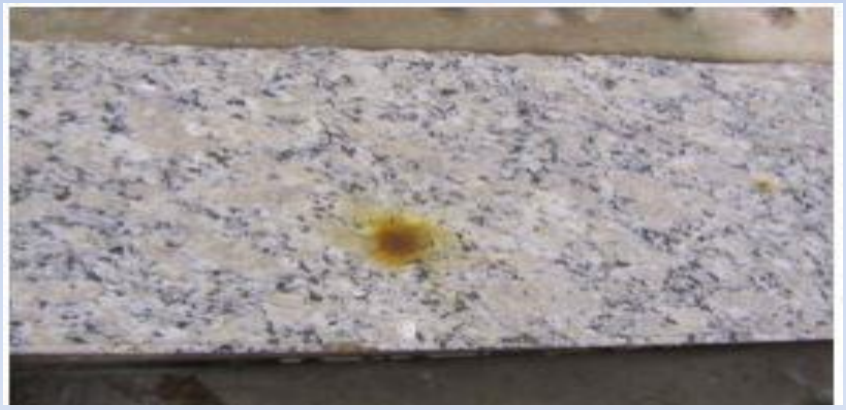
- Stone, in general, is considered a durable material; however, not all stones are as durable as one might anticipate.
- Stone durability is dependent on its composition, which can affect strength and appearance, and environmental exposure factors.
- The composition and physical properties of stones vary significantly, even for stone removed from slightly different areas of a single quarry or formation.
- Small variations in some stone types can result in significant differences in durability performance in service.
- Stone durability is greatly influenced by its use and exposure.
- Factors that contribute to accelerated deterioration of stone include exposure to moisture, freeze/thaw cycles, temperature extremes, rain acidity, and crystallization of salts. While all of these factors are influenced by project location and local climate.
- The colour and thickness of the stone may, in certain situations, affect its durability, as a dark coloured stone will experience greater temperature extremes than light coloured stone, and a thin stone will not experience moderate temperature extremes through its thickness as much as a thicker stone.
- A poor durability stone can result in diminished building appearance, may require supplemental repairs to address deterioration, or in extreme cases may require replacement of panels



Surface Spalling of limestone specimen



Thin-section view of stone with adjacent porous and non-porous layers. Variable absorption presents a potential concern under cyclic freezing and thawing.



Stain spot on granite specimen

Surface spalling on sandstone specimen

STONE QUARRYING

- It is known that stones occur in nature in the form of natural rock masses forming hills or walls of valleys. These have to be broken and extracted from those natural outcrops for using in the construction. The process of extraction of suitable stones from their natural place of occurrence for use in construction is called *quarrying*.
- Quarrying is different from mining. In case of a mine, the operations are carried out under the ground at greater depth. In case of quarry, the operations are carried out at ground level in an exposed condition.

Site for Quarry :

The selection of site for a quarry of stones should be done after studying carefully the following aspects :

i. Availability of tools, power, materials and labour for the easy and efficient working of quarry

ii. Availability of site for dumping of refuse and avoiding health hazards, if any;

iii. Distance of quarry from roads, railways, sea coast, etc., and proximity to the transportation facilities

iv. Drainage of quarry pit

v. Easy availability of clean water in sufficient quantity all the year round

vi. Economy in quarrying

vii. Facility of carrying and conveying stones from quarry

viii. For quarrying by blasting, absence of permanent structures in the nearby area

ix. Geological data regarding rock formations at the site

x. Quantity of stone available from quarry

xi. Quantity of stone likely to be obtained from quarry

Important considerations for starting the quarry :

Following are the important considerations which are to be carefully paid attention to before actually starting the quarry :

1) ***Examination of rock surface :*** The exposed surface of rock bed should be carefully examined. The presence of cracks and fissures are to be notes. The planes, along which stones will easily split should be found out to make quarrying operations quick and economical.
2) ***Lay out :*** It is necessary to prepare a complete lay out of various stages involved in quarrying operation. The faulty planning leads to the failure of quarry.
3) ***Men and Machines:*** There should be proper co-ordination between man and machines employed on the quarry so as to obtain maximum advantage from them.
4) ***Removal of top surface :*** The loose soil and soft rock present at the top surface of quarry should be removed. The material obtained from top surface is unsuitable for construction work and hence it should be rejected. The dense rocks are available at a depth which depends on the weathering qualities of a rock.
5) ***Structural stability :*** The stones should be removed from the quarry without affecting the structural stability of its sides. If proper precautions are not taken, there may be serious slips or landslides with disastrous results.

Methods of Quarrying

Following are the *three* methods of quarrying :

1. ***Quarrying with hand tools :***

- ✓ There are three different ways of doing quarrying by the use of hand tools. Those are Digging or Excavating, Heating and Wedging.
- ✓ In *Digging or excavating* method, the stones are merely excavated with the help of suitable instruments such as hammers, showels, chisels etc., This method is useful when soft stones occur in the form of large or small blocks.
- ✓ In *Heating* method, the top surface of rock is heated by placing pieces of wood or by piling a heap of fuel over the surface and setting a steady fire to them for some hours. This method is useful when small blocks of more or less regular shape are to be taken out from quarry and when the rock formation consists of horizontal layers of shallow depth.
- ✓ In *wedging* method, if rocks contains cracks or fissures the steel wedges or points are driven through such cracks by means of hammers. The wedging is adopted for costly stratified rocks which are comparitively soft such as laterite, marble, limestone, sandstone,etc.,

Quarrying by Wedging

2. Quarrying with channelling machine :

- ✓ In this method, the channelling machines driven by steam, compressed air or electricity are used to make vertical or oblique channels on the rock mass.

The process consists of the following steps:

a. The channels are cut around the stone block which is to be removed from the rock mass.

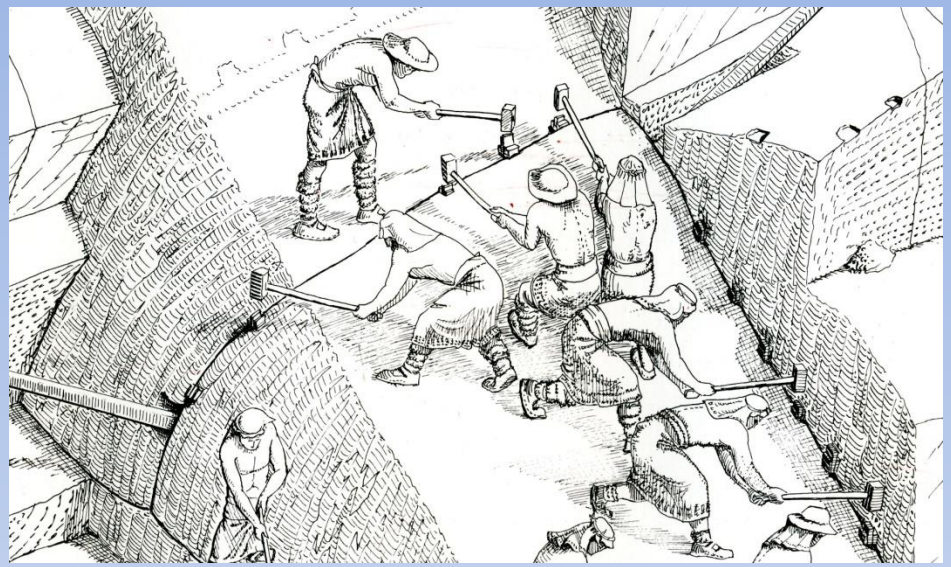
b. The horizontal holes are drilled beneath the block.

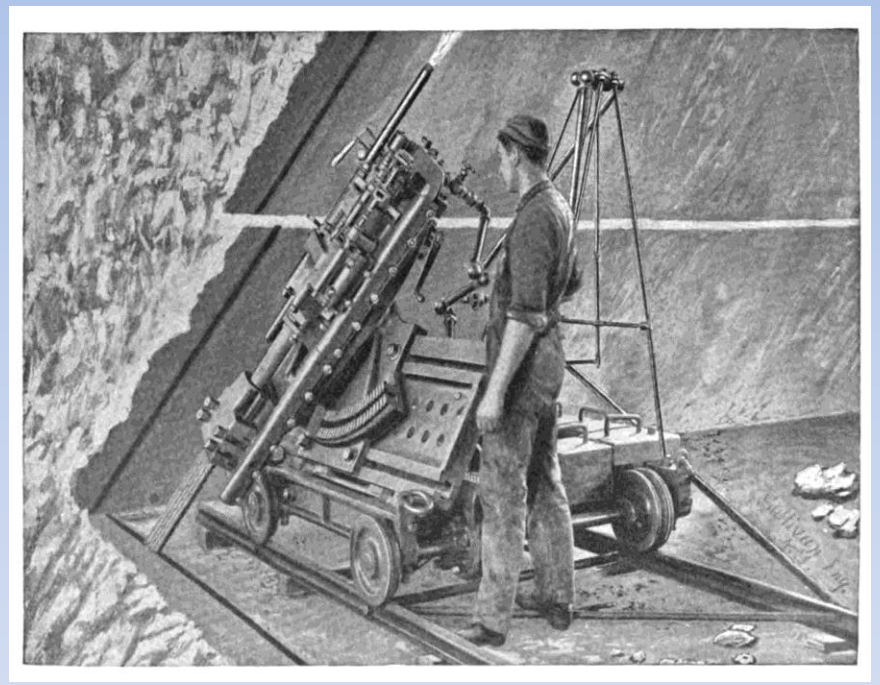
c. The wedges are driven into the holes and the block is then broken loose from its bed.

It is possible to separate very large blocks of stones from the rocks by the application of this method.

3. Quarrying by Blasting : In this method, the explosives are used to convert rocks into small pieces of stones.

- ✓ The main purpose of this method is to loosen large masses of rocks and not to violently blow up the whole mass so as to convert it into very small pieces of practically no use.
- ✓ This method is adopted for quarrying hard stones, having no fissures or cracks. The stones obtained by blasting are of small size and are used as ballast in railways, aggregate for concrete, road metal etc.,





DRESSING OF STONES

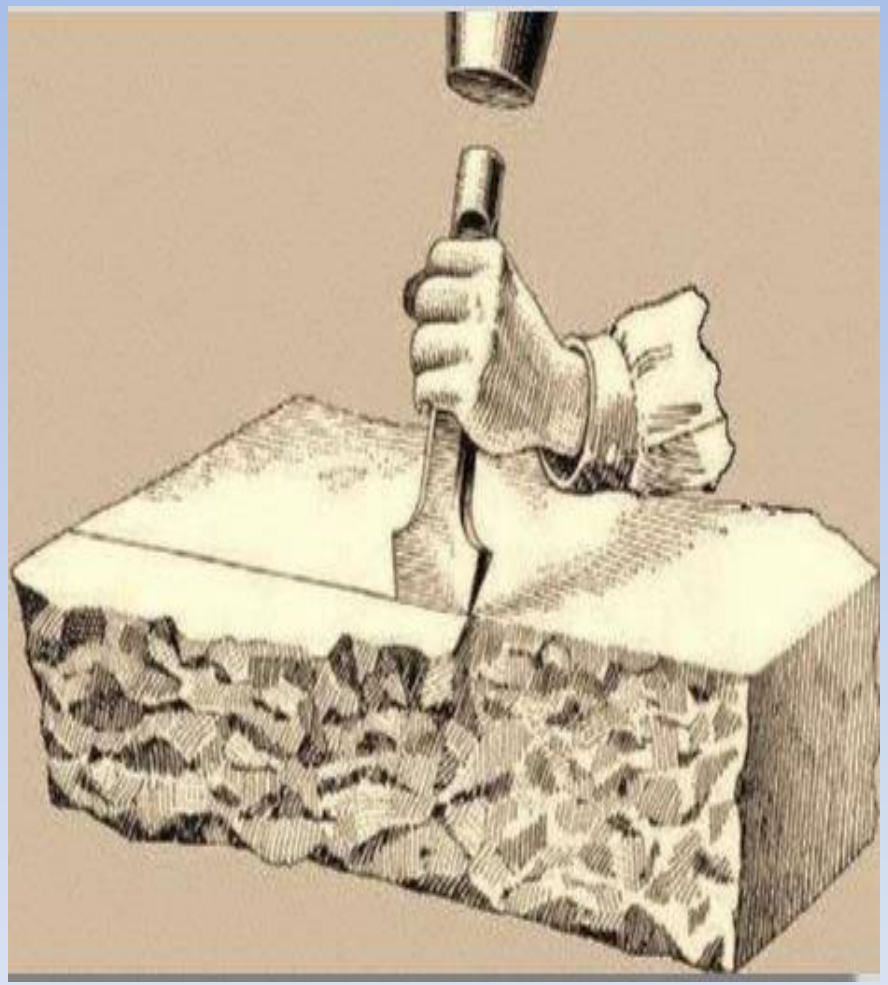
The stones, after being quarried, are to be cut into suitable sizes and with suitable surfaces. This process is known as the dressing of stones and it is carried out for the following purposes :

a) To get the desired appearance from stone work,

b) To make the transport from quarry easy and economical.

c) To suit to the requirements of stone masonry,

d) To take advantage of local men near quarry who are trained for such type of work etc.,



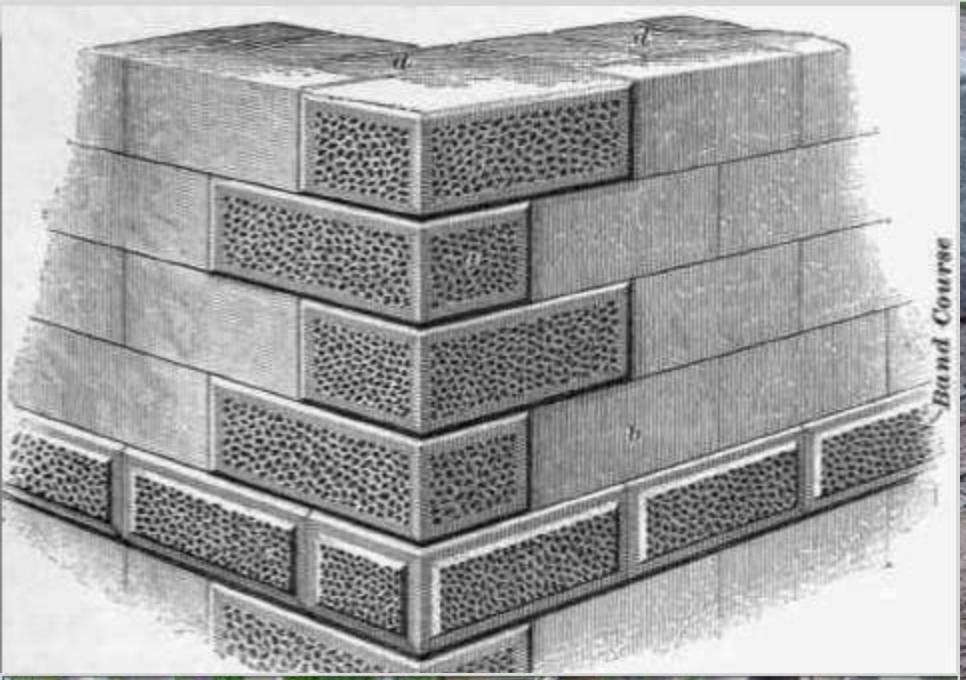
Stones as obtained from quarries are very rough and irregular in shape. Besides, they may be too bulky to be used in construction, Hence various objectives of dressing are:

(a) *To reduce the size of blocks to easily portable units* : This is often done at the quarry itself because transport of big rock may be costly.

(b) *To give a proper shape to the stone*

We can use stones in foundation as blocks, in walls as small units, in floor as slabs and in column as rounded or square pillars. Each situation requires a proper shape that has to be given under the process of dressing.

(c) *To obtain an appealing finish* Stones always come in rough and rugged forms. For use in building construction in walls and exteriors, they have to be given an aesthetic appealing finish. A stone house has its own distinction, beauty and individuality in a concrete jungle.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Selection of Stones For Construction

Three factors are generally considered by an engineer while deciding use of stone in construction jobs:

1. The type of building and the situation where stone is to be used such as :

a) Residential building or a public building, such as for school, department office, community centre etc.

b) Commercial building like cinema hall, shopping complex stadium, etc

c) A monument building such as temple, mosque, church, fort etc.

2. The precise location in the building where the stone shall give a preferential benefit in terms of cost, appearance, and durability such as in foundations, superstructures, arches, columns, beams, plinths, or flooring, sills and cantilever.

3. Cost of construction with stones. This will depend on factors of availability of stone, in nearby area, their extraction, transportation and dressing before putting them in use. Sometimes a desired quantity of stone may not be available locally. It may have to be imported from other states or even from other countries.

PRESERVATION OF STONES

- The stones with exposed faces are acted upon by various atmospheric and external agencies so as to cause their deterioration.
- The decay of building stones of inferior quality is to some extent prevented, if they are properly preserved. For this purpose, the preservatives are applied on the stone surfaces.

An ideal preservative has the following properties :

i. It does not allow moisture to penetrate the stone surface
ii. It does not develop objectionable colour
iii. It hardens sufficiently so as to resist effects due to various atmospheric agents.
iv. It is easily penetrated in stone surface
v. It is economical
vi. It is non – corrosive and harmless
vii. It remains effective for a long time after drying
viii. Its application on stone surface is easy.

- It should however be remembered that there is not a single preservative which is suitable for all types of stones. The choice of a preservative therefore requires careful consideration depending upon the chemical composition of stones and their location in structure, a particular preservative should be recommended. Each care should be properly studied before a final choice is made.

Following are the preservatives which are commonly adopted to preserve the stones :

1. Coal Tar

If coal tar is applied on stone surface, it preserves stone. But the colour of coal tar produces objectionable appearance and surface coated with coal tar absorbs heat of the sun. Hence this preservative is not generally adopted because it spoils the beauty of stones.

2. Linseed Oil

This preservative may be used either as raw linseed oil or boiled linseed oil. The raw oil does not disturb the original shade of stone. But it requires frequent renewal, usually once in a year. The boiled oil lasts for a long period, but it makes the stone surface dark.

3. Paint

An application of paint on stone surface serves as a preservative. The paint changes the original colour of stone. It is applied under pressure, if deep penetration is requires.

4. Paraffin

This preservative may be used alone or it may be dissolved in neptha and then applied on stone surface. It changes the original colour of stone

5. Solution of alum and soap

The alum and soft soap are taken in proportion of about 0.75 N and 0.50 N respectively and they are dissolved in a litre of water. This solution , when applied on stone surface, acts as preservative.

6. Solution of baryta

A solution of barium hydroxide $Ba(OH)_2$, when applied on stone surface, acts as a preservative. This preservative is used when the decay of stone is mainly due to calcium sulphate, $CaSO_4$.

Following chemical reaction takes place.

$$Ba(OH)_2 + CaSO_4 = BaSO_4 + Ca(OH)_2$$

The barium sulphates is insoluble and it is least affected by atmospheric agencies. The calcium hydroxide absorbs carbon dioxide from atmosphere and forms calcium carbonate CaCO3 which adds to the strength of stone.

References

“Engineering Materials “ by RANGWALA

“Building Construction “ Dr. B.C. Punmia

www.slideshare.net

Google references

Thank You