JHARKHAND Rai University
RANCHI

# MINING ENGINEERING
# LAB MANUAL

## ROCK MECHANICS
## (DIPLOMA)
## SEMESTER VI

# LIST OF EXPERIMENTS

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# EXPERIMENT: 01

**AIM:** Sample Preparation for various rock testing in laboratory.

**Materials & Equipment:**

1. Diamond saw
2. Raw rock core
3. Grinder
4. Caliper, ruler
5. Craftsman lathe
6. Magic pen

**THEORY:**

In Mining operations we mainly deal with hard rocks with different physico-Mechanical properties. Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. All reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. These practices specify procedures for laboratory rock core test specimen preparation of rock core from drill core and block samples for strength and deformation testing.

The dimensional, shape, and surface tolerances of rock core specimens are important for determining rock properties of intact specimens. All these dimensions must be according to the standards recommended by ISRM. The moisture condition and the original physical condition of the specimen at the time of the sample preparation can have a significant effect upon the strength and deformation characteristics of the rock. Good practice generally dictates that laboratory tests be made upon specimens representative of field conditions. Thus, it follows that the field moisture condition and physical conditions of the specimen should be preserved until the time of the test.

**PROCEDURE:**

1. Each student will select one kind of rock and cut 5 samples. The ratio of length/ diameter should be at least 2.0
2. Grind both ends until they become parallel to within the 0.003 inches. Check it using the craftsman lathe.
3. Grind both ends of the specimen so that it will be near vertical to the axis of the specimen within 0.001 radian.
4. Mark the roll number and specimen number using magic pen.


**A Typical cylindrical Rock Sample**

**Fig : Cylindrical Sample Preparation Machine**

## EXPERIMENT: 02

**AIM:** To determine of Point Load Index of rock.

**Materials & Equipment:**

1. Rock samples.
2. Point load strength test machine
3. Pressure gauge (Capacity 25 kN or 50 kN)

**THEORY:**

A wide array of index tests has been evolved over the past three decades to evaluate the strength and deformation behavior of coal and rocks, both in intact specimens and in the rock mass. Such empirical strength measurement techniques offer much potential for wider use in routine measurements as they offer significant benefits in terms of cost-effectiveness, skill and manpower requirements. Amongst the various empirical indices in use, the Protodyakonov Index and the Point Load Index (Broach and Franklin, 1972) are marked by their simplicity of determination vis-a-vis other strength tests proposed to date. To be of use and realistic in application, the data obtained from these tests must ultimately be related to some fundamental strength parameter of rock.

**PROCEDURE:**

Point load test

1. The diametric test is conducted on rock core sample. Minimum of 10 test specimens are required to find out the average value of point load strength index.
2. This test can be conducted on the core specimens which are completely dry or after soaking it for 7 days.

3. Measure the total length (**l**) and diameter (**d**) of the core specimen. Specimen of **l/d=1.5**, are considered to be suitable for this test.

4. Place the specimen horizontally between two platens in such a way that the distance between the contact point and the nearest free end (**L**) is at least 0.75times the diameter of the core (**d**).
5. Measure the distance between two platen contact points (**D**) with the help of the scale attached with the loading frame. (Note-In case of diametric test, the diameter of the core (**d**) and the distance between two platens (**D**) will be same)
6. Apply load to the core specimen such that failure occur within 10-60 sec. record the failure load '**P**'.

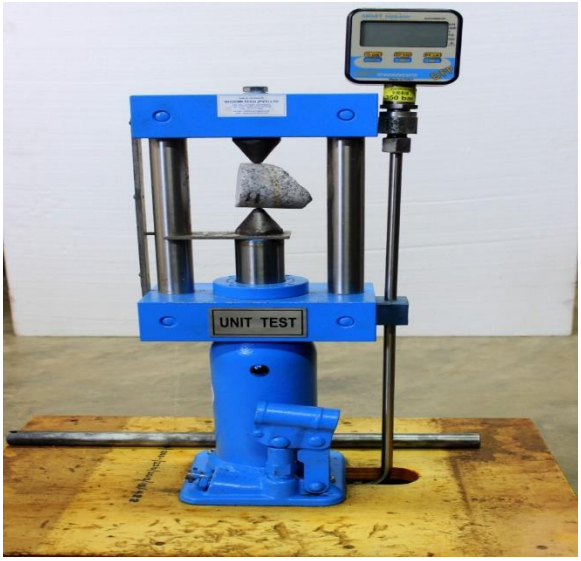
Observation Table

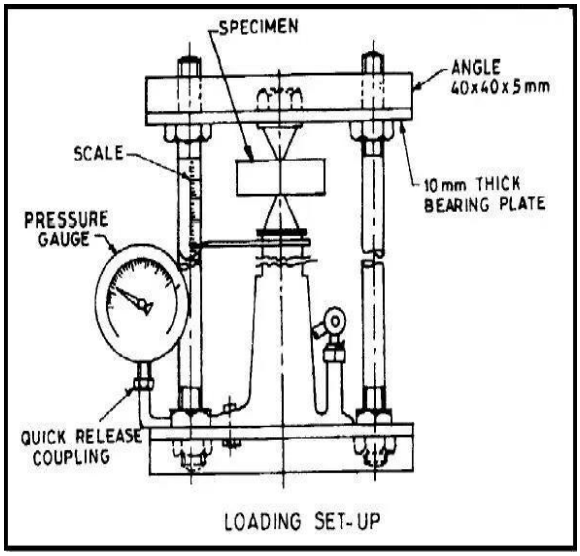
| Sl no. | Load (KN) | Diameter of sample (cm) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

**Point load strength index ($I_s$) = (P*1000)/$D^2$ Mpa**

Where **P** is breaking load in kN

**D** is the distance between platens in mm




Point Load Index Testing Apparatus

## EXPERIMENT: 03

**AIM:** To determine Uniaxial Compressive strength of rock.

**Materials & Equipment:**

1. Universal Testing Machine.
2. Rock Samples.

**THEORY:**

Rock strength is measured by laboratory testing. Strengths are very different depending on the stress field applied to the rock. All rocks and soils are very much stronger in compression than in tension.

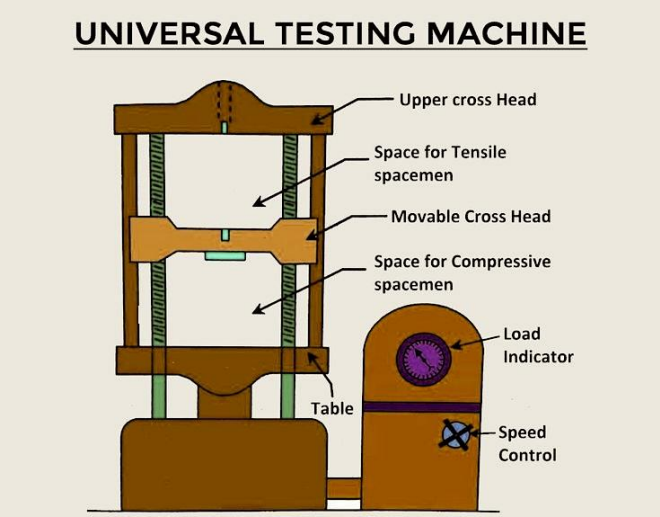
The two common laboratory tests to determine the compressive strength of rock are:

- Uniaxial Compression Test - A cylindrical rock core is loaded axially until it fails.
- Triaxial Compression Test - A cylindrical rock core is placed in a cell, subjected to all around (confining) pressure by hydraulic oil acting through a thin impermeable membrane, and loaded axially to failure.

| Sl No. | Load (KN) | Diameter of sample (cm) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**PROCEDURE:**

For compression testing core sample (a cylinder) is subjected to a loading arrangement in Universal Testing Machine. At failure point the load is noted down and strength is calculated out.




Universal Testing Machine

## EXPERIMENT: 04

**AIM:** To determine indirect tensile strength of rock (Brazilian Test).

**Materials & Equipment:**

1. Universal Testing Machine.
2. Rock Samples.

**THEORY:**

Rock strength is measured by laboratory testing. Strengths are very different depending on the stress field applied to the rock. All rocks and soils are very much stronger in compression than in tension.

There are a variety of tests to determine the tensile strength of rock:

- Direct Pull Test - A cylindrical rock core sample is anchored at both ends and stretched.
- Brazilian Test - A relatively thin disk is load across the diameter until it splits.
- Beam Flexure Test - A thin slab of rock is loaded vertically when supported at three or four points along its length.

| Sl No. | Load (KN) | Diameter of sample (cm) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**PROCEDURE:**

For tensile test, Brazilian arrangement is preferred. Again the core sample (a disc) is subjected to UTM arrangement and strength is calculated out at the failure point reading. For Brazilian Test a relatively thin disk is load across the diameter until it splits. At failure point the load is noted down and strength is calculated out.


Brazilian Testing Apparatus

## EXPERIMENT: 05

**AIM:** To determine of shear strength of rock.

**Materials & Equipment:**

1. Shear box.
2. Rock Samples.

**THEORY:**

Rock strength is measured by laboratory testing. Strengths are very different depending on the stress field applied to the rock. All rocks and soils are very much stronger in compression than in tension.

The portable field shear box is used to directly measure the shear resistance of joint surfaces. The shear-box provides information on the shear strength and shear stiffness of jointed rock masses.

**PROCEDURE:**

For shear test; a Shear Box is used. A block with a natural fracture is cemented into a split-box mould with the fracture surfaces in contact. When the cement or plaster is cured, normal and shear loads are applied using hydraulic jacks. The displacement is measured with a dial-gauge.

**Shear Test Apparatus**

## EXPERIMENT: 06

**AIM:** To determine the Protodyakonov strength index of rock.

**Materials & Equipment:**

1. Rock samples.
2. Volumometer
3. PSI apparatus.
4. A 100 mm scale attached with the loading frame
5. Pressure gauge (Capacity 25 kN or 50 kN)

**THEORY:**

A wide array of index tests has been evolved over the past three decades to evaluate the strength and deformation behavior of coal and rocks, both in intact specimens and in the rock mass. Such empirical strength measurement techniques offer much potential for wider use in routine measurements as they offer significant benefits in terms of cost-effectiveness, skill and manpower requirements. Amongst the various empirical indices in use, the Protodyakonov Index and the Point Load Index (Broach and Franklin, 1972) are marked by their simplicity of determination vis-a-vis other strength tests proposed to date. To be of use and realistic in application, the data obtained from these tests must ultimately be related to some fundamental strength parameter of rock.

**PROCEDURE:**

**Protodyakonov strength index test:**

For Protodyakonov strength index test which is generally carried out in case of coal, samples each weighing 50-70 gm, in the form of irregular coal pieces of 10-14 mm in size were crushed individually in a hollow cylinder of 76 mm internal diameter by a free-falling weight of 2.4 Kg five times from a height of 0.6 m.

The fines so produced, of size below 500 microns, were combined and the height of the fines column measured in a volumometer of 23 mm diameter. The index ($I_f$) was calculated by the following formula:

$$PSI = \frac{20\times NxM}{H}$$

Where: PSI- Protodyakonov strength index

N- No. of samples

M- No. of impacts or blows

H- Height of fine material in volumometer five determinations are carried out for each coal sample and the mean value reported as the Protodyakonov Index.

| Weight of Sample taken | No. of Sample (N) | No. of Impacts(M) | Height of fine material in volumometer (H) |
|---|---|---|---|
| | | | |
| | | | |


Protodyaknov strength Apparatus