Safety Guidelines

Rock Mechanics Laboratory

Department of Mining Engineering

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1 General Hazards in the Rock Mechanics Laboratory

The purpose of this document is to implement the risk based safety management system in the Rock Mechanics Laboratory of the Department of Mining Engineering. The first step is to identify the potential hazards associated with the available infrastructure and conducting experiments/testing in the laboratory. Once the potential hazards are identified, the existing controls and protection measures are reviewed. In the process of review of the existing controls, if the existing controls are found to be inadequate, additional controls are suggested. This enables the users and visitors in the laboratory to take due care of safety and avert any untoward incident that may lead to serious accident.

Accordingly this manual first deliberates on the general hazards associated with the laboratory, then further sections of the document explains the safety management in the use of equipment available in the laboratory. The standard operating procedures (SOPs) have been developed for use of major equipment in the laboratory based on the risk based safety management system.

1.1 Hazard related to electrical installations

S. No.	Existing / Potential hazards (General Electrical)	Existing controls / protection	Additional Controls	Remarks
1	Fire from electrical apparatus / switches	1. Old mains switches are available	1. Switch boards must be provided with suitable MCBs and other safety features 2. Suitable Fire extinguishers shall be provided near main switch boards and distribution boards 3. All technical staffs to be trained in use of fire fighting apparatus (FFA) 4. Procedure to be prepared for checking of FFA 5. FFA to be periodically checked 6. Expiry of FFA to be checked 7. Buckets of sand to be kept at suitable locations 8. All old wirings in the lab to be replaced with conduit wiring and circuit breakers. 9. ELCB to be installed in the mains of the lab. 10. Wooden panels in vicinity of old cables to be removed/suitably protected. 11. Windows should open easily when lab is conducted, to avert asphyxiation of persons inside the room in case of fire.	

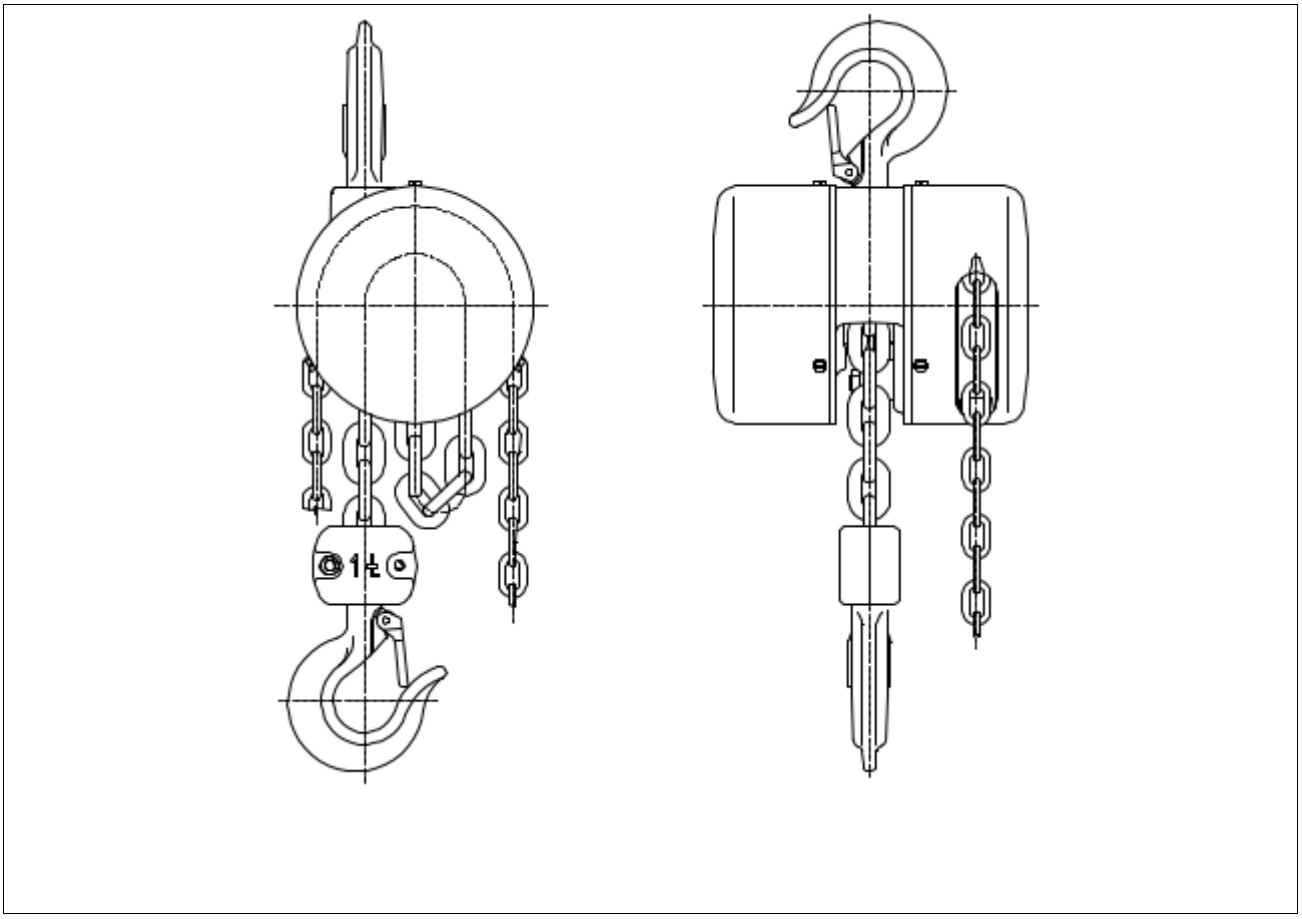
1.2 General / common Hazards

S. No.	Existing / Potential hazards (General Injury)	Existing controls / protection	Additional Controls	Remarks
1	slip, trip and fall hazard	1. Non-slippery concrete floor provided in laboratory. 2. Arrangements for drainage of water in rock cutting lab provided.	1. Fluorescent painting to be made on floor having elevation difference and also for demarcating safe distance from machine. 2. Temporary barricading to be installed 3. Friction rubber mats to be provided at conspicuous locations	

	Injury of the feet by hitting hard objects lying on floor	Proper housekeeping	4. Warning boards to be provided at conspicuous locations 5. Shoes to be worn while in the laboratory Use of safety shoe to be made mandatory	
2	Fall of materials from height	1. Supervision 2. Training 3. Helmets to be worn	1. Prohibitory order for complete elimination of working under suspended load is to be issued and implemented. . 2. Table tops to be provided with friction rubber mats 3. Presence of loose materials above ground to be examined regularly.	
3	Injury due to lack of illumination	1. Tube lights provided	1. Additional LED lights to be installed	
4	lack of communication while operating equipment	1. All operation under supervision of Technical staff	1. Procedure for communication to be developed. 2. Provision of portable audio system in noisy environment.	
5	Biological hazard (snake bite, rats, cats)	1. Periodic pest control measures	1. Doors and windows to be repaired to prevent entry of animals / snakes etc. 2. Snake entry points to be sealed. 3. Periodic cleaning of grass and bushes around the outside boundary of the lab.	
6	Unauthorized entry	1. Supervision	1. Prohibitory notice boards to prevent unauthorised entry to be provided 2. fluorescent lines to be marked on floor	
7	Emergency exits	1. Grilled Gates available	1. Aluminium panelled glass doors to be provided.	
8	Injury on feet due to hitting rock samples, other materials lying on floor		1. Improving house keeping 2. Use of shoes 3. Adequate illumination	

1.2 Hazard related to lifting of heavy material using chain blocks

Chain blocks (Figure shown below) are designed solely for hand vertical lifting and lowering of free loads in the workplace. The load mass must not exceed the specified nominal lifting capacity as provided by the manufacturer. Numerous accidents have taken place during the use of chain blocks and danger exists when loads are lifted, particularly when the chain block is not used properly or is poorly maintained. This can result in an accident or serious injury. Therefore special safety precautions are applicable to the operation with the chain block during its assembly, maintenance and inspection. The golden rule for use of chain pulley blocks is "Proper rigging and lifting techniques are the responsibility of the operator".



S. No.	Existing / Potential hazards (General Injury)	Existing controls / protection	Additional Controls	Remarks
1	Failure of chain pulley block causing injury Damage in the components of the chain	• Visual inspection • Supervision	• Checking of chain block at regular interval. • Maintaining records of examination • Testing of chain pulley block.	
2	Crushing the fingers / hands while operating chain block due to incorrect assembly.		• Correct the entangled links of the chain. • Use of handgloves	
3.				
4.	Cuts from sharp edges	there can be sharp edges or pressed metal chips on the chain. To avoid injury, protective gloves should be worn	Use of hand gloves is mandatory	
5	Fatigue cracks	Visual inspection	Testing of chain blocks at regular interval	
6	Fall of hanging load	Cautioning all personnel to move away from the hanging load.	• Working under suspended load is to be completely banned. • Suitable caution boards to be provided	

S. No.	Existing / Potential hazards (General Injury)	Existing controls / protection	Additional Controls	Remarks
			• Marking danger zone before lifting heavy load • Barricading danger zone • Supervisors to ensure persons are not within danger zone	

Based on the hazards associated with the use of chain pulley blocks, the standard operating procedures are enumerated as under.

1.4.1 Standard Operating Procedure of using chain pulley block

i. Golden Rule: **No person should stand or work under suspended load**
ii. Suitable caution boards to be provided
iii. Marking danger zone before lifting heavy load
iv. Barricading danger zone must be ensured
v. Supervisors to ensure persons are not within danger zone
vi. NEVER lift more than lifting capacity shown on the chain block nameplate.
vii. ALWAYS make sure the load carrying structure will provide adequate support to handle fully loaded chain block and all the lifting operation.
viii. ALWAYS let people around to know when a lift is about to begin.
ix. Provide notice board for the golden rule “Proper rigging and lifting techniques are the responsibility of the operator”.
x. Only authorised personnel are allowed to use the chain blocks.

Procedures to be followed prior to use of chain blocks

i. ALWAYS ensure physically fit, qualified and instructed persons over 18 years of age, and trained in safety conditions and way of work, operate the chain block.
ii. ALWAYS check the chain block daily before use
iii. ALWAYS make sure the length of chain is long enough for the intended job.
iv. ALWAYS check the brake function before use.
v. DO NOT use repaired chain only.
vi. ALWAYS ensure the load chain is not corroded, is cleaned and oiled.
vii. ALWAYS make sure the last link of load chain is strongly fastened to the body.
viii. NEVER use damaged or worn out chain block.
ix. NEVER use chain block with jumped out, damaged or missing hook’s safety latch.
x. NEVER use a chain block without a visible marking of the lifting capacity.
xi. NEVER use modified or deformed hooks.
xii. NEVER connect or lengthen the load chain.
xiii. NEVER use a chain block marked by the label „OUT OF SERVICE“.
xiv. ALWAYS consult the manufacturer or his authorized representative, if you plan to use a chain block in non-standard or extreme environments.

Procedures to be followed when the chain block is in use

i. ALWAYS make sure the load is properly seated in the hook.
ii. ALWAYS make sure the safety latches of hooks work in the correct way
iii. ALWAYS pay attention to the limit positions.
iv. NEVER use a chain block for tensioning, pulling or anchoring loads.
v. NEVER allow swinging the load, causing impacts or vibrations.
vi. NEVER use a chain as a sling
vii. NEVER hitch a load on the tip of the hook.
viii. NEVER pull the chain over any edge.
ix. NEVER weld, cut or make any operation on a suspended load.
x. NEVER operate a chain block, if chain is jumping or atypical or excessive noise occurs.

Procedures to be followed after use of chain block

i. NEVER leave a load suspended.
ii. ALWAYS ensure the chain block against incompetent use.

Procedures to be followed for Maintenance of chain block

i. ALWAYS Ensure competent personnel inspect the chain block regularly.
ii. ALWAYS ensure the chain was clean and oiled.
iii. ALWAYS ensure the sliding parts were greased enough.
iv. NEVER add other parts for lengthening the load chain.

2 Hazard identification and SOP for operation of 600 T Compression Strength Testing Machine (CSTM)

2.1 Brief description of the 600 T CSTM and the associated hazards

The compression strength testing machine serves the purpose of determination of compressive, buckling and bending strength of standard specimens and structural members for mining and construction including rock and concrete structures. It is an electro hydraulic machine. The test pad of the machine is widely spaced to enable large size plates and specimens to be tested in upright position up to a load of 600 ton. The machine also comprises of with-drawable bending beam allowing for testing of bending specimens at a distance of supports up to 2.2 m. The machine is partly installed under the floor level, rendering the specimens to fit and to dismantle them at the ground level. The three major parts of the machine are (I) Testing Machine including columns, cross head and the base portion (ii) Leakage oil unit, installed below the ground level (iii) Operating Desk. (Figure shown below). Detailed operating instructions are available in the “Operating Manual (Ref. Key Number EL 138 66)” provided by the manufacturer, M/s GDR-705, Leipzig, Alfred-Kastrer Street.69, Germany.

The hazards associated with the use of 600 T CSTM are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Fire due to Oil leakage	1. proper earthing of the machine	1. Checking for Hydraulic leakages around the machine by the operator before starting the machine 2. Providing proper ELCB	
2	Electrical hazards • Fire from electrical short circuit • Electric shock to while operating machine due to earth leakage current	• Maintaining proper earthing	Please refer Sl. 1 Section 1.1 • Testing of leakage current • Providing suitable fire fighting apparatus	
3	Collision with obstructions	1. No wire should run over the X-	1. Operator and demonstrator must	

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
	while raising the cross head e.g. loose wires or other fixtures	head. 2. Obstructions if any must be removed 3. No object to be placed that obstructs the vision between the operator standing at the operating desk and the X-head.	ensure proper clearance of obstruction above the cross head. 2. Dedicated and experienced operators to operate the machine.	
4	Fall of hanging load, e.g. chain pulley block while placing specimen on the test pads	1. Person moving in vicinity of the test pad must ensure no loads are hanging. 2. The hanging load must be shifted to safe location	1. Proper rail to be placed on the roof beam to tame the hanging load of chain pulley block to a safe location. 2. Helmets should be worn by persons working in vicinity of the hanging load. 3. Helmets to be procured for operators, demonstrators and visitors.	
5	While applying load, broken sample may hit the Instructor / Technician / Students / Visitors and cause serious injury	1. Skill & competency of technical staff 2. Supervision	1. Induction training / initial briefing 2. Providing a guard or screen while applying load 3. Maintaining a safe distance for the students / visitors 4. Providing face shields, Protective eye glass.	
6	Injury on feet due to hitting rock samples, other materials lying on floor	Pl. refer sl. 8 Section 1.3	Pl. refer sl. 8 Section 1.3	
7	Serious cut injury while using rock testing tools	Pl. refer Sl. 1 Section 1.3	Pl. refer Sl. 1 Section 1.3	

2.2 Standard operating procedure (SOP) for 600 T CSTM

Based on the hazards identified and existing as well as additional controls as discussed in Section 2.1, the SOP for operation of the 600 T compression strength testing machine is given as under.

Standard Operating Procedure and Controls:

1 Only dedicated/authorised and experienced operators must operate the machine.

2 Before demonstration, an initial briefing regarding the potential hazards shall be explained to the students or visitors

3 Operator must assess the oil leakages in vicinity of the machine before starting the machine.

4 If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.

5 Operator and demonstrator must ensure proper clearance of obstruction above the cross head.

6 Proper rail to be placed on the roof beam to tame the hanging load of chain pulley block to a safe location.

7 Helmets should be worn by all persons working in vicinity of the hanging load.

8 Proper guard or screen should be placed around sample while applying load to prevent broken sample hitting the Instructor / Technician / Students / Visitors and causing serious injury

9 The operator and the instructor must ensure maintaining a safe distance for the students / visitors

10 Providing face shields/ Protective eye glass should be worn by persons working in vicinity of the specimen being tested.

3 Hazard identification and SOP for operation of 100 T MTS Closed Loop Electro Hydraulic Testing System (MTS CLEHTS)

3.1 Brief Description of the 100 T MTS CLEHTS and the associated hazards

The 100 T MTS Closed Loop Electro Hydraulic Testing System is used for materials or structures testing. The system is a single channel type i.e. it has one hydraulic actuator and one servo controller. The picture shows the major parts of the machine. The 'closed loop' is a continuous path of interacting elements. If this path is broken at any point while hydraulic pressure is applied to the servo-valve, closed loop control will be lost and the entire hydraulic actuator will stroke to its extensive or refractive limit. The machine has following parts.

(a) **Hydraulic power supply**: The hydraulic power supply provides a source of hydraulic fluid under pressure for the system the output pressure is usually set at 210.9 kg/cm^2 and the output flow is between 7.5 to 40 litres per minute.

(b) **Hydraulic actuator:** the hydraulic actuator is the force generating and/or positioning device in the system. Fluid under pressure is applied to one side of the piston causing it to move. If the Piston rod contacts some external reaction point, a force is applied to that point that is equal to the effective piston area times the actuating pressure. The hydraulic actuator is contained in the load frame for material testing.

(c) **Servo valve**: the Servo valve controls the hydraulic actuator by opening or closing in response to the control signal from the valve driver or controller. The Servo valve can open in either of two directions. Thus high pressure fluid can flow into the cylinder on either side of the piston causing movement in either of the two directions. When the servo valve is opened to allow fluid to flow into one end of the cylinder it, also provides a path for fluid to flow from the other end of the cylinder back to the power supply. The servo-valve is a proportional device, i.e. it allows a rate of fluid flow that is in direct proportion to the magnitude of the control signal.

(d) **Servo controller and valve driver or controller**: The main function of the servo controller is to accept and compare its two main inputs 'command' and 'feedback' and to provide an output called the error signal which is proportional to the difference between the two inputs. The main function of the valve driver or valve controller is to amplify the error signal, producing a servo valve control signal

(e) **Transducers**: Transducers sense some quantity generated by the hydraulic actuator such as force or linear displacement (piston stroke) and provide and output signal which represents that quantity.

The detailed operation and maintenance of the machine is provided in the MTS reference manual volume I to volume IV and soft copies of the controller are maintained in the control PC of the machine.

The hazards associated with the use of 100 T MTS CLEHTS are given in the table below

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Oil leakage and electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	While applying load, broken sample may hit the Instructor / Technician / Students / Visitors and cause serious injury	Please refer Section 2.1, Sl.5	Please refer Section 2.1, Sl.5	
3	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	
4	Hazards due to use of high pressure hydraulic power pack	Please refer Section 11.1 (All associated hazards)	Please refer Section 11.1 (All associated hazards)	

3.2 Standard operating procedures of the 100 T MTS CLEHTS

1. Only competent, authorised and experienced operators shall operate the machine.
2. Before demonstration, an initial briefing regarding the potential hazards shall be explained to the students or visitors
3. Operator must assess the oil leakages in vicinity of the machine before starting the machine.
4. If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
5. Operator and demonstrator must ensure proper clearance of obstruction above the cross head.
6. Proper guard or screen should be placed around sample while applying load to prevent broken sample hitting the Instructor / Technician / Students / Visitors and causing serious injury
7. The operator and the instructor must ensure maintaining a safe distance for the students / visitors
8. Face shields/ Protective eye glass should be worn by persons working in vicinity of the specimen being tested.

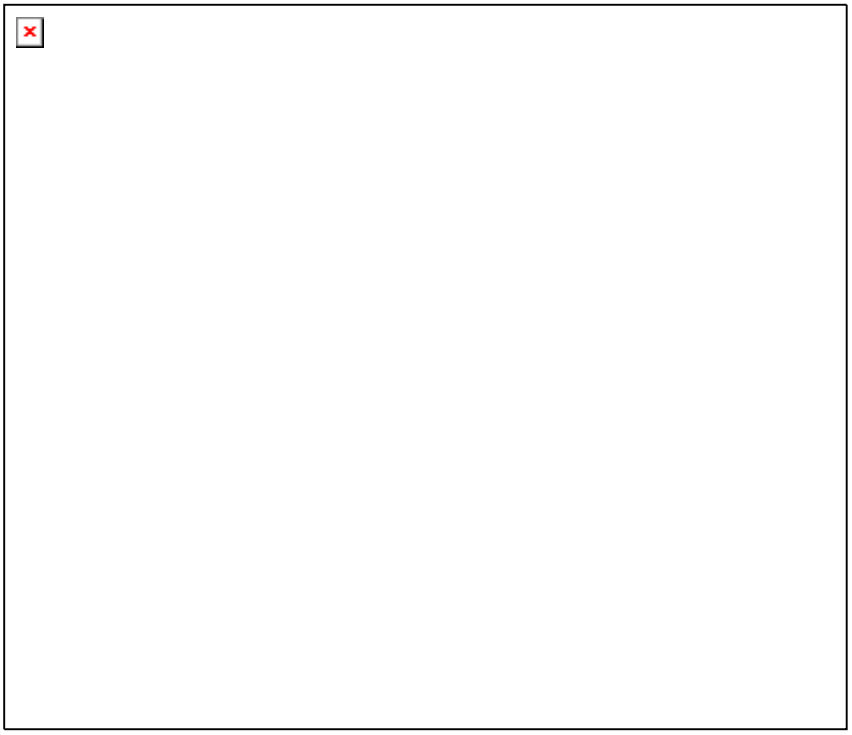
4 Hazard identification and SOP for operation of 20 T Electronic Universal Testing Machine (20 T EUTM)

4.4 Brief Description of the 20T EUTM and the associated hazards

The machine comprises of three main parts.

(a) Machine frame i.e. loading unit

(b) Hydraulic system
(c) Electronic display unit



The machine frame consists of two cross heads and one lower table. Centre cross head is adjustable by means of geared motor. Compression test is carried out between centre and lower table, and tension test is carried out between centre and upper cross head. Sensing of the load is by means of precision pressure transducer of strain gauge type.

For measurement of ram stroke, a rotary encoder is fitted in the bottom of the machine. Adjustable limit switches are provided for the safety limiting and positioning of the centre cross head. Also adjustable limit switches are provided for safety for limiting the ram stroke. Hydraulic system consists of motor pump unit with cylinder and piston. Safety relief valve is provided for additional safety.

The hazards associated with the use of 20 T Electronic Universal Testing Machine are given in the table below

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Please refer Section 2.2, 2.3 & 2.4	Please refer Section 2.2, 2.3 & 2.4	Please refer Section 2.2, 2.3 & 2.4	

4.5 Standard operating procedure (SOP) for 20T EUTM

Please Refer to Section 3.2.

5 Hazard identification and SOP for operation of Drilling, Boring & Tapping Machine (Make Kitchen-Walker)

Brief Description of the Drilling, Boring & Tapping Machine (Make Kitchen-Walker) and the associated hazards

The drilling boring and tapping machine installed in the specimen preparation laboratory is used mainly for recovering core-specimens from large lumps/blocks of rocks received from field. The machine has four parts.

(a) The base plate
(b) column with elevating screw
(c) Radial arm
(d) control head with spindle column assembly.

Details of the numbered items in the above figure are given in the table below.

1	Combined lock lever to entire machine	2	Engage power feed by pushing lever in, disengage by pulling out
3	Lock lever for depth setting	4	Traverse to head
5	Push button for power elevation to arm	6	18-spindle speed changes. Stop motor to change
7	Trip to feed lever	8	Master control Forward, stop, reverse & inch to spindle
9	9-spindle feed changes	10	Forward reverse motion
11	Fine hand feed		

All controls on the drilling machine are concentrated on the control head placed on the radial arm which is within easy reach of the operator. Detailed operation and maintenance instructions are available in the user manual issued by the supplier.

The hazards associated with the use of Drilling, Boring & Tapping Machine are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Oil leakage and electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	Injury due to movement of radial arm	Supervision Training Engage power feed lever must be kept in locked position	Radial swing area of the arm must be fenced to avoid inadvertent entry of visitors and students.	
3.	Slippage of rock specimen from the sample holder	Proper tightening of the samples using wooden blocks	Wooden wedge blocks to be made thick rubber sheets to be provided before clamping Clamping arrangement is to be fabricated.	
4	While applying load, broken sample may hit the Instructor / Technician / Students / Visitors and cause serious injury	Please refer Section 2.1, Sl.5	Please refer Section 2.1, Sl.5	
5	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

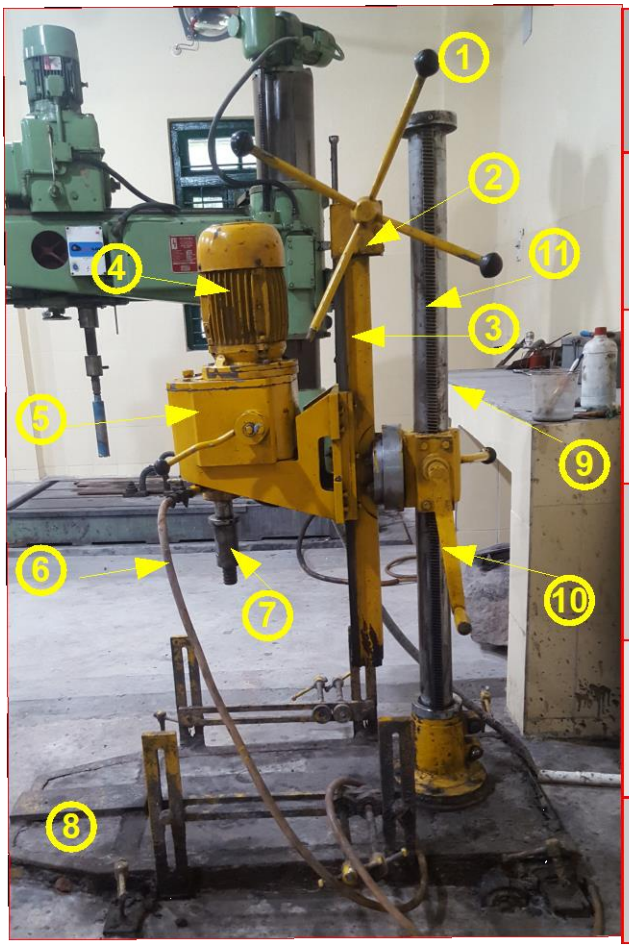
5.2 Standard operating procedure (SOP) for Drilling, Boring & Tapping Machine (Make Kitchen-Walker)

1. Only authorised and experienced operators must operate the machine.
2. Before demonstration, an initial briefing regarding the potential hazards shall be explained to the students or visitors.
3. Engage power feed lever must be kept in locked position
4. Operator must assess the oil leakages in vicinity of the machine before starting the machine.
5. If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
6. Operator and demonstrator must ensure proper clearance of obstruction in the swing area of the arm of the machine.
7. Proper locking should be placed around the sample while drilling to prevent sample slipping and hitting the Instructor / Technician / Students / Visitors and causing serious injury
8. The operator and the instructor must ensure maintaining a safe distance for the students / visitors
9. Face shields/ Protective eye glass should be worn by persons working in vicinity of the specimen being drilled.
10. The spindle speed should not be changed while the machine is running. The master control lever must be brought to stop position and when the spindle speed is almost nil. The gear change lever must then be activated smartly to the required position.

6 Hazard identification and SOP for operation of Motorised Core Drilling Machine (Model HR 72-10)

Brief Description of the Motorised Core Drilling Machine and the associated hazards

The core drilling machine is ideally suitable for taking out cores of rock or concrete specimen in laboratory The whole machine is fixed on the floor. The base also carries a vice for necessary clamping of the specimen. The whole assembly carrying the gear box slides on the pillar (9). Upward and downward movement is initiated by means of a worm gear drive through a handle. Slide (3) can be rotated through any angle right from 0°-360°. Care should be taken that slide (3) should be clamped firmly after changing of the angle. Movement to the gear box assembly carrying the bit is given through gear arrangement (5). Gearbox is powered by 2 H.P. three-phase motor capable of giving two speeds to the bit that is 900 RPM and 300 RPM. For wet cutting inlet and outlet (6) pipes are provided.



1	Leading screw handle	2	Gear
3	Sliding	4	Motor
5	Gear box	6	In let and outlet pipe
7	Cutter spindle	8	Base
9	Pillar	10	Lifting handle
11	Rake		

The hazards associated with the use Motorised Drilling Machine are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Oil leakage and electrical	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
	earth leakage while starting the machine			
2	Injury due to movement of slide	Supervision Training	The swing area of the slide must be fenced to avoid inadvertent entry of visitors and students.	
3.	Slippage of rock specimen from the sample holder	Please refer Section 5.1, Sl.3	Please refer Section 5.1, Sl.3	
4	While applying load, broken sample may hit the Instructor / Technician / Students / Visitors and cause serious injury	Please refer Section 2.1, Sl.5	Please refer Section 2.1, Sl.5	
5	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

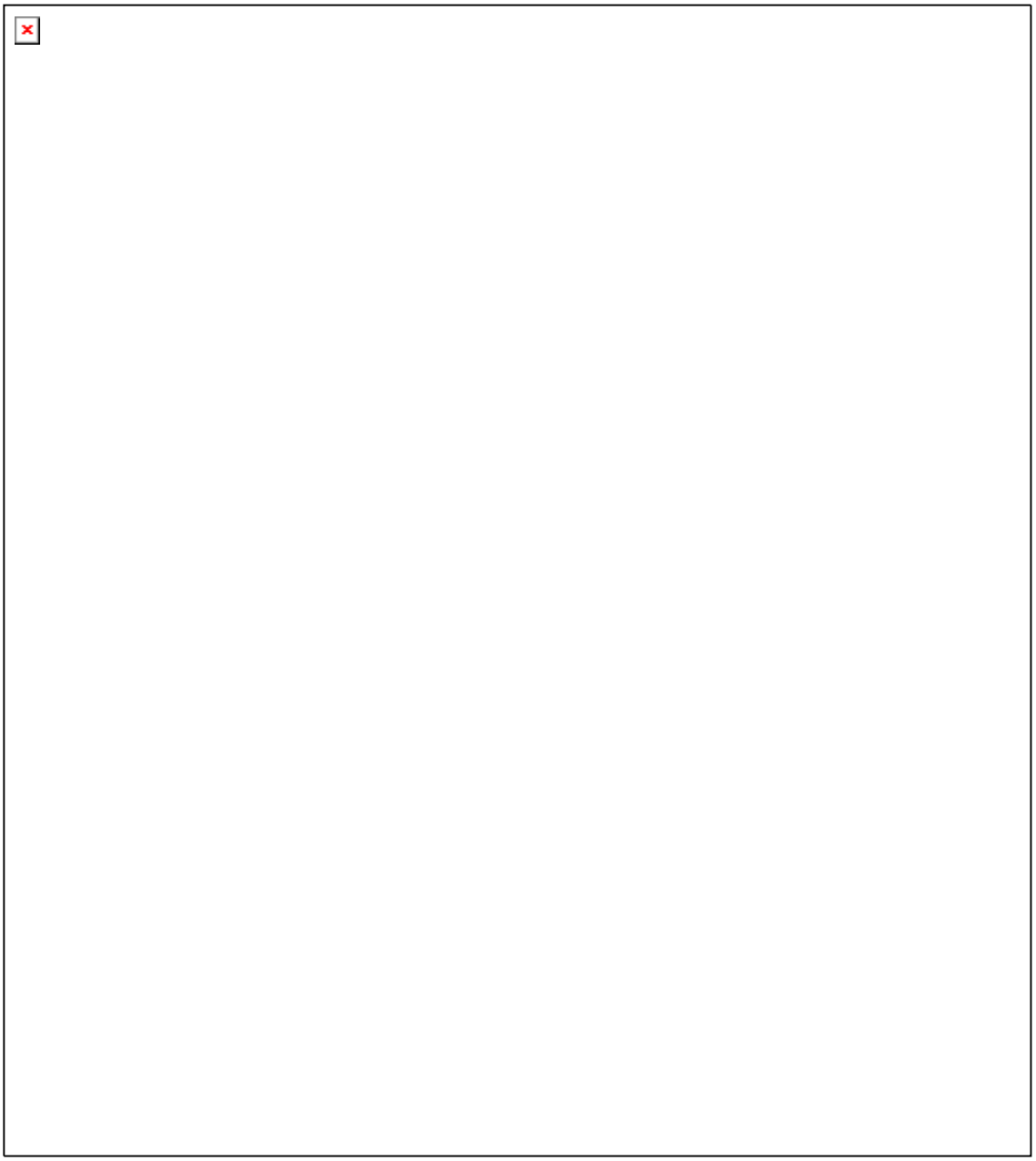
Standard operating procedure (SOP) for Motorised Core Drilling Machine

7 Only dedicated/authorised and experienced operators must operate the machine.
8 Before demonstration, an initial briefing regarding the potential hazards shall be explained to the students or visitors.
9 The gear should not be shifted when the machine is running.
10 Oil level in the gear must be checked prior to start.
11 The operator must be vigilant while running the machine and he must always be within the reach of the emergency switch.
12 If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
13 Operator and demonstrator must ensure proper clearance of obstruction in the swing area of the slide of the machine.
14 Proper locking should be placed around the sample while drilling to prevent sample slipping and hitting the Instructor / Technician / Students / Visitors and causing serious injury
15 The operator and the instructor must ensure maintaining a safe distance for the students / visitors
16 Face shields/ Protective eye glass should be worn by persons working in vicinity of the specimen being drilled.

17 Hazard identification and SOP for operation of Rock Cutting Machine (Model HR 72.05)

Brief Description of the Rock Cutting Machine and the associated hazards

After obtaining the specimen of various sizes ranging from EX-NX with the Core Drilling Machine, it is required to size the specimen (length wise) as per the requirements of the test. The machine is equipped with 300 mm diameter blade suitable for cutting specimen right from 20 mm diameter to 100 mm with any L/D ratio that is 1 or 2. The machine is fabricated in a sturdy channelled frame. The blade of 300 mm diameter is powered by a 5 H.P. three phase motor operating on 440 v.



The speed of the blade is adjusted at 280 or 2900 RPM. Care should be taken as regards the direction of rotation of the blade which is clearly marked on it. There are two vertical motion adjustments for the blade, i.e. (1) and (4). Lever (1) is foot operated and is to be thrust down to the maximum when the specimen is being pushed towards the blade for cutting. Adjustment (4) is for step increment of withdrawal of the blade assembly. Paddle (1) is fixed to the channel frame with the help of spring by (2). When foot is removed from the (1),blade assembly automatically moves up. To ensure smooth upward motion of the blade a dash-pot is incorporated. This prevents any jerky motion.

Slide (6) moves on the wheeled cradle (5). Cradle moves in the perpendicular axis of the blade on the railing. Stoppers are provided on each side of the railing to prevent the over-running of the cradle. Vice have two motions (1) angular and (2) parallel to the blade. While moving the vice parallel to the blade, utmost precaution should be taken not to bring any metal

part in contact with the blade. 'V' block vice can take specimen ranging from 20mm to 100 mm. If angular cutting is required, then the vice is to be set at that particular angle marked on the vice.

The hazards associated with the use Motorised Drilling Machine are given in the table below.

S. No.	Existing / Potential hazards (General Injury)	Existing controls / protection	Additional Controls	Remarks
1	**Hazard related to serious cut injury while using rock cutting tools**			
	Serious cut injury while using rock testing/ cutting tools	1. Proper sample holders available with some machines only. To be used with other machines also for ensure safe distance from cutting tools 2. Use of hand gloves 3. Only authorized persons to use the cutting tools 4. Emergency stop switches	1. Proper sample holders to be provided and used with all other machines also for ensure safe distance from cutting tools 2. Regular maintenance of sample holders 3. Supervision and training of the technical personnel operating the machine. 4. Stop switches to be maintained properly and checked before start of operation 5. First Aid box with sufficient stock of essential items 6. Use of hand gloves to be made compulsory while cutting and using sharp tools. 7. Notice regarding danger of loose garments shall be displayed 8. No person with loose garments shall be allowed while using cutting tools.	
2	Oil leakage and electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
3	Injury due to movement of cradle when in motion	Supervision Training	Proper guard to be made to prevent manual adjustment	
4	Slippage of rock specimen from the V-block	Bolt provided	Butterfly bolt rubber spacer	
5	While cutting, broken sample may hit the Instructor / Technician / Students / Visitors and cause serious injury	Please refer Section 2.1, Sl.5	Please refer Section 2.1, Sl.5	
6	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

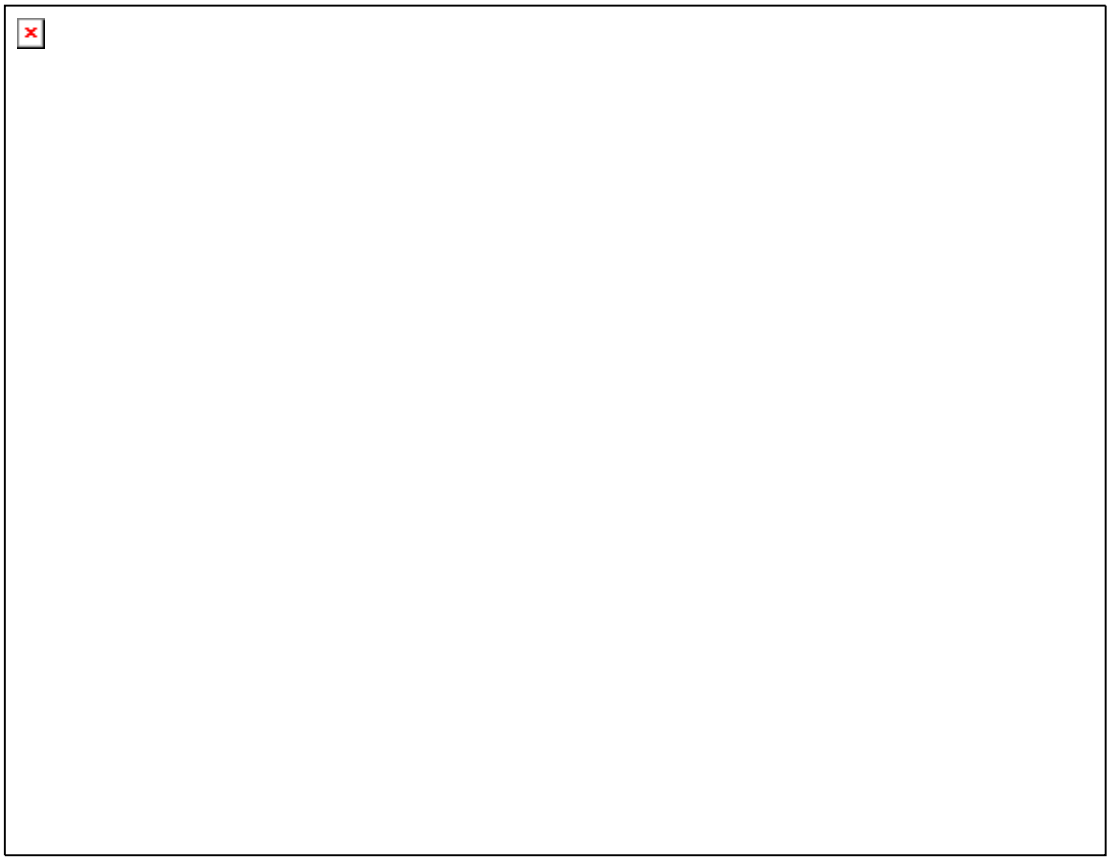
17.2 Standard operating procedure (SOP) for Rock Cutting Machine

1. Only competent, authorised and experienced operators shall operate the machine.
2. Proper sample holders to be provided in all machines for ensure safe distance from cutting tools
3. Emergency stop switches to be maintained for stopping machine in emergency
4. Stop switches to be checked before start of operation
5. First Aid box with sufficient stock of essential items
6. Use of hand gloves to be made compulsory while cutting and using sharp tools.
7. Notice regarding danger of loose garments shall be displayed
8. No person with loose garments shall be allowed while using cutting tools.
9. Supervision and training of the technical personnel operating the machine.
10. Before demonstration, an initial briefing regarding the potential hazards shall be explained to the students or visitors.
11. Care should be taken so that no metal part comes in contact with the blade while cutting.
12. Ensure the direction of the rotation of the blade is in accordance with the marking on the machine
13. Oil level in the gear must be checked prior to start.
14. The operator must be vigilant while running the machine and he must always be within the reach of the emergency switch.
15. If the earth to neutral voltage exceeds the prescribed limit of (15 V), electrical maintenance engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
16. Operator and demonstrator must ensure proper clearance of obstruction in the swing area of the blade of the machine.
17. Proper guarding must be provided to ensure no person puts hand near the blade while the machine is operating.
18. Proper locking should be placed around the sample while cutting to prevent sample slipping and hitting the Instructor / Technician / Students / Visitors and causing serious injury
19. The operator and the instructor must ensure maintaining a safe distance for the students / visitors
20. Provision of screen around the machine to prevent flying broken rocks or tools
21. Face shields/ Protective eye glass should be worn by persons working in vicinity of the specimen being drilled.

18 Hazard identification and SOP for operation of Motorised 50kN Direct Shear Apparatus (Model AIM-106)

Brief Description of the Motorised 50kN Direct Shear Apparatus and the associated hazards

The equipment is used for determining the shear strength of sands and gravels. In fact, the main development of Direct Shear test has been the use of a large box (30 cm sq. x 15 cm high) for testing gravelly clays and clayey gravels used in rolled fill embankments. It is designed for a maximum normal load of 50 KN/m^2 (5 kgf/cm^2) and a maximum shear load of 50 kN (5000 kgf). It is a constant rate of strain type equipment and gives 72 rates of deformation. It operates on 415 volts, 50 Hz, three phase, AC supply.



Details of the numbered items in the above figure are given in the table below.

1	Frame	2	Gear box
3	Speed change turret gear box	4	Turret setting wheel
5	Adjustment wheel	6	Lead screw
7	Water jacket lifting handle	8	Key
9	Dial gauge holder	10	Loading U-Arm
11	Abutment screw	12	Abutment bracket
13	Change gear stand	14	Roller strip
15	Water jacket	16	Loading yoke
17	Loading lever	18	Weight hanger
19	Counter balancing weight	20	Fulcrum screw travel limit indicator

The hazards associated with the use 50 kN Shear Testing Machine are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	Injury due to handling of	Supervision	The machine must be aligned with the chain	

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
	shear plates	Training Overhead chain pulley block	pulley block	
3.	Fall of hanging load, e.g. chain pulley block while placing the shear plate on the machine	Please refer Section 1.4	Please refer Section 1.4	
4	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

18.2 Standard operating procedure (SOP) for Motorised 50kN Direct Shear Apparatus

1. The machine should be used only under the supervision of dedicated/authorised and experienced operators.
2. The machine should not be used by a single person. Assistance of additional worker trained in safety aspects of the machine should be taken.
3. Before using the machine a demonstration and an initial briefing regarding the potential hazards shall be obtained by the students.
4. Helmet and shoes are to compulsorily worn by those using this machine.
5. The operator must be vigilant while running the machine and he must always be within the reach of the emergency switch.
6. If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
7. Operator and demonstrator must ensure proper clearance of obstruction in the swing area of the chain block.
8. Proper care is to be taken to add the loads to the lever of the machine to avoid injury to hand and feet.
9. The operator/demonstrator/instructor must ensure maintaining a safe distance for the students / visitors
10. Provision of screen around the machine to prevent flying broken rocks or tools

19 Hazard identification and SOP for operation of Direct/Residual Shear Apparatus, Multiple Reversal Type, Motorised – 12 Speed (Model AIM10 – 1701, AIM-104)

Brief Description of the Direct/Residual Shear Apparatus, Multiple Reversal Type, Motorised – 12 Speed and the associated hazards

The equipment meets the essential requirements of 1S:2720 (Part XIII). It has a normal load capacity of 8 kgf/cm^2, when loads are applied through lever and 1.6 kgf/cm^2 when loads are applied directly. It has arrangement for applying twelve rates of strain from -0002mm/min to 1.25mm/min. With such facilities the apparatus provides means to conduct various types of shear tests on large variety of soils and study shear strength characteristics. The following tests can be performed with this apparatus.

1. Undrained test or quick test

2. Consolidated - undrained or consolidated quick test
3. Consolidated-drained test or slow test

4. Multiple reversal test to obtain residual strength.

This apparatus is designed for easy operation. Tests on this apparatus provide information about the ultimate shear resistance and enable to compute angle of shearing resistance and cohesion intercept of soil samples. The apparatus also provides facility for measuring the residual strength apart from peak shear strength. The information obtained from the tests on this apparatus is of importance in design of sub-structure, in determining bearing capacity of soils, and in stability calculations of earth slopes etc. It operates on 220 volts, 50 Hz., single phase, AC supply.

The machine is of constant strain type in which twelve rates of strain can be applied. The apparatus has two main units, shear box with water jacket and loading unit, which are illustrated in figure below. attached.

The hazards associated with the use Shear Testing Machine are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	Injury due to handling of weights on weight manager	Supervision Training	Safety boot and glover are mandatory	
3	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

19.2 Standard operating procedure (SOP) for Direct/Residual Shear Apparatus, Multiple Reversal Type, Motorised – 12 Speed

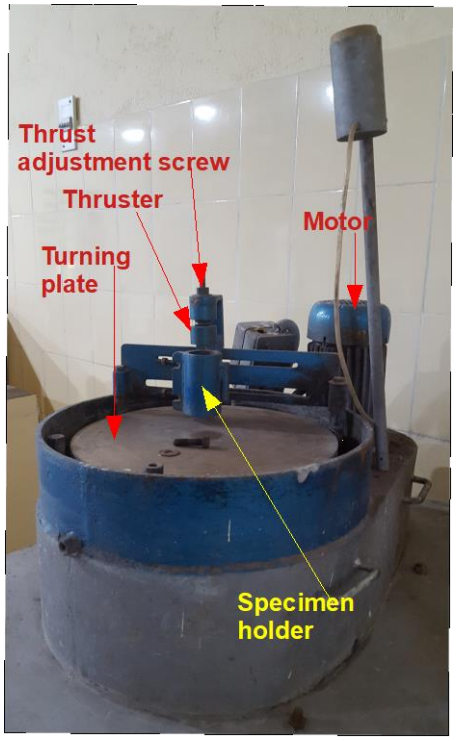
1. The machine should be used only under the supervision of dedicated/authorised and experienced operators.

2. Before using the machine a demonstration and an initial briefing regarding the potential hazards shall be obtained by the students.
3. Gloves and shoes are to compulsorily worn by those using this machine.
4. The operator must be vigilant while running the machine and he must always be within the reach of the emergency switch.
5. If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
6. Proper care is to be taken to add the loads to the lever of the machine to avoid injury to hand and feet.
7. The operator/demonstrator/instructor must ensure maintaining a safe distance for the students / visitors
8. Provision of screen around the machine to prevent flying broken rocks or tools

20 Hazard identification and SOP for operation of Rock Grinding Machine

Brief Description of Rock Grinding Machine the associated hazards

The Rock grinding machine is used for grinding and polishing the edges of the rock core specimens that have been cut by the rock cutting machine. It consists of rotating table/turning plate powered by 2 HP motor. The specimen is pressed against the rotating plate with the help of a thruster. The thrust to the specimen is provided by the thrust spring and the amount of thrust can be controlled using the adjustment screw provided in the thruster.



The hazards associated with the use of Rock Grinding Machine are given in the table below.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	Injury to hand while rock is being polished	Avoid touching the turning plate	Use of sample thruster to be made mandatory Regular maintenance of specimen thruster. Use of hand gloves.	
3	Injury on feet due to hitting rock samples, other materials lying on floor	Please refer Section 2.1, Sl.6	Please refer Section 2.1, Sl.6	

20.5 Standard operating procedure (SOP) for Rock Grinding Machine

1. The machine should be used only under the supervision of dedicated/authorised and experienced operators.
2. Before using the machine a demonstration and an initial briefing regarding the potential hazards shall be obtained by the students.
3. Gloves and shoes are to compulsorily worn by those using this machine.
4. The operator must be vigilant while running the machine and he must always be within the reach of the emergency switch.
5. If the earth to neutral voltage exceeds the prescribed limit of (15 V), qualified electrical engineer must be contacted to rectify the problem. When the ELCB is provided, it should not be bye-passed.
6. The sample should be ground using thruster only. Hand pressing is not allowed.
7. The operator/demonstrator/instructor must ensure maintaining a safe distance for the students / visitors

21 Hazard identification and SOP for operation of High Pressure Hydraulic Hand Pumps / Power Packs

Brief Description of the High Pressure Hydraulic Hand Pumps / Power Packs and the associated hazards

High pressure hydraulic hand pumps / power packs are a convenient, portable source of hydraulic power. They are designed to be stable during operation. Hydraulic equipments and systems are designed to accomplish work using confined liquid pressure to produce a greater mechanical force. The operators/ maintenance crews are subjected to hazards from high pressure liquids and large mechanical forces. Hydraulic systems store fluid under high pressure.

The following hazards and their control measures have been identified.

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
1	Oil leakage and electrical earth leakage while starting the machine	Please refer Section 2.1, Sl.1	Please refer Section 2.1, Sl.1	
2	Burns from hot, high-pressure fluid	Condition monitoring by way of visual checks	-	

S. No.	Existing / Potential hazards associated with demonstration / testing / maintenance	Existing controls / protection	Additional Controls	Remarks
3	Injection of fluid into the skin	Maintain safe distance from pressurised lines and parts.		
4	Fire Hazards	Please refer Section 1.1, Sl.1	Please refer Section 1.1, Sl.1	
5	bruises, cuts or abrasions from flailing hydraulic lines	Condition monitoring of critical hydraulic parts and hoses training and supervision		
6	injury of people due to unexpected movement of equipment. During maintenance of equipment and their parts.	Supervision Training		
7	Injury due to sudden release of residual pressurized oil.	Supervision skill training		
8	Slippage due to oily floor area.	Please refer Section 1.3, Sl.1	Please refer Section 1.3, Sl.1	

21.5 Standard operating procedure (SOP) for High Pressure Hydraulic Hand Pumps / Power Packs

In response to the hazards identified as above, the following SOP for High Pressure Hydraulic Hand Pumps / Power Packs is recommended.

For Hand Pumps

1. For best performance, operate the pump handle at moderate speed. When the handle gets hard to push at high pressure, take short strokes. The maximum leverage is obtained in the last 5 degrees of stroke. Adding an extension to the pump handle is dangerous and is not recommended.
2. Close the release valve finger tight only. Using tools on the release valve can damage it and cause the pump to malfunction.
3. In certain situations the pump handle can “kick back.” Always keep your body to the side of the pump, away from the line of force of the handle.
4. Many hand pumps can be operated in the horizontal or vertical position. However, when using it in the vertical position, the hose end must be down or you will pump air instead of oil.
5. Check the pump instruction sheet to determine the correct operating position for your pump.
6. Clean all areas around the oil ports of the pump and the unit’s quick disconnect coupling.

For hand pumps and Power Packs

1. Inspect all threads and fittings for signs of wear and damage. Replace as needed. Clean all hose ends, couplers, and union ends.
2. Connect the hose assembly to the hydraulic pump oil outlet and couple the hose to the power unit’s quick disconnect.
   IMPORTANT: Seal all pipe connections with Teflon tape. Apply the tape in a clockwise direction relative to the top a total of 1-1/2 times. Apply the tape carefully to prevent it from being pinched by the coupler and broken off inside the pipe end. Any loose pieces of tape could travel through the system and obstruct the flow of oil or cause jamming of precision parts.
3. Attach one end of the hose to the high pressure port of the desired equipment and the other end of the hose to the high pressure port of the power unit.
4. Put off the motor power from MCC and lock out & Tag out. Obtain permit to work as per plant procedures.

5. Depressurize the system before start of work. Shut down/ Local Isolation may be taken, if required.
6. Never begin work on a hydraulic system until fully trained.
7. Never begin work on a hydraulic system without using a risk assessment.
8. Carefully review the manuals on equipments before beginning work. Ask questions about anything you do not fully understand.
9. Read the Material Safety Data Sheet (MSDS) for chemicals used.
10. Use all required safety Equipments.
11. Never try to repair a part without having full knowledge about it.
12. Each hydraulic system must have a documented procedure of de-energizing and load locking. This should be known to all maintenance personnel.
13. Document and practice de-pressurizing procedure in each of the circuit.
14. While testing the system after repair never stand close to the unit. Any component, pipe, hose, fitting may fail.
15. Before start of work, drain the pressure line up to the actuator.
16. If pressure gauge is showing zero, then also bleed the hose for confirmation.
17. During the tightening of pressurized lines hammering should not be done.
18. Tightening of Joints should be done in depressurized condition.
19. In any of the hydraulic maintenance jobs, all other agencies working in that area should be well communicated about the hydraulic work and its effects.
20. All hydraulic pipes and hydraulic cylinders should be tested at 1.5 times working pressure. All accumulators should be tested for its wall thickness and pressures as per Factories Act.
21. Do not use bare hand to check the hydraulic leakage; any fluid leakage through pinhole leakage can be injected into your skin. Use a card board or wooden piece to check leakages.
22. Hot work like gas cutting, welding should be avoided near hydraulic pipeline or near tank.
23. Any modification being carried out in Hydraulic System Circuit, should be approved by competent authority.
24. Do not weld on a hydraulic reservoir/sump without emptying the oil.
25. Ensure all vents (air breather & hatch plate) should be opened. For any maintenance/ cleaning job to release entrapped gases.

For Hoses & fittings

26. Before replacing hoses, depressurize the system
27. Check the hose or hoses to be replaced by twisting or squeezing them to see if the pressure has been relieved, or by another method suitable to the hose being used. If pressure is still in the hose or hoses, take appropriate measures to relieve the pressure before loosening the fittings. Care to
28. be taken that replacement of hose should be with hoses with same size and specifications.
29. Each and every hose in a hydraulic system must be able to handle the highest pressure produced by the system. Pressure surges or peaks exceeding the hose rated working pressure are destructive and must be considered when selecting a hose. Please ensure compatibility of hose with design pressure of system.
30. Improper Length/Routing - Forcing a hose into an improper geometry causes high stresses in the hose components that may also reduce pressure capacity (avoid multi-plane bending, small bend radii, tension in hose, etc.). Hose life can be reduced by 90% when subject to these type of stresses
31. Abrasion and Cuts - Wear against other hoses or objects will wear off the outer cover and lead to corrosion of the reinforcing mesh.
32. Extreme Pressure Fluctuations - Pressure surges above the hose working pressure will damage hose components.
33. Vibration - Cyclic loading of hoses can damage hose components even when motion seems relatively small.
34. Hoses having bulges or getting wet surface to be immediately replaced.