

STANDARD  
OPERATING  
PROCEDURE  
(SOP)

FOR  
OPERATING  
UCS TESTING  
MACHINE



# UNIAXIAL COMPRESSIVE STRENGTH (UCS)

STANDARD OPERATING PROCEDURE (SOP) FOR OPERATING THE UNIAXIAL  
COMPRESSIVE STRENGTH (UCS) TESTING MACHINE FOR STRENGTH TEST  
AND ANALYSIS PURPOSES

LOCATION - FACILITY	MOSELEY MORAMORO
SUBDIVISION	MINING – OK TEDI LABORATORY
REVISED EDITION	1 <sup>ST</sup> EDITION
REVIEW DATE	1 <sup>ST</sup> JULY 2022
DRAFTED BY	P. RUMINTS (SENIOR TECHNICAL OFFICER)

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# NOTE

## USAGE POLICIES & INSTRUCTIONS

- This equipment can only be operated upon approval from either the Laboratory Manager or a Technical Officer, or operated with the assistance or supervision of a technical officer.
- Strict compliance to operating procedures and safety requirements is required to operate this equipment. No Exceptions for substandard practices!
- If this equipment is acting unusual while operating STOP IMMEDIATELY! Please REPORT this malfunction to the Technical Officer and discuss the severity of the fault before proceeding or tag-out as faulty equipment.
- Any accidental damage to equipment or incidents encountered while operating this equipment must be reported immediately.



# EQUIPMENT DETAILS

## Uniaxial Compressive Strength (UCS) Testing Machine

### Purpose:

This SOP ensures that the operator may operate this equipment appropriately according to the operating procedures to get reliable output without damages to the equipment or causing injuries to the operator. The Uniaxial Compressive Strength (UCS) testing machine is used to conduct 3 different types of strength tests on industrial materials, mostly rock specimens, to determine the compressive strength, tensile strength and transverse or bending strength (flexural strength) of the rock specimens from applying load on the specimen until failure or fracture.

This UCS Testing machine is composed of a main load frame which applies the load to a test specimen and a dynamometer which displays the load applied, as measured.

### Hazards:

- Eye protection (safety glasses) against projectile fragmented pieces
- Footwear (safety boots) for equipment components or test specimen fragments falling on to the foot.

### Safety Requirements:

#### Personal Protective Equipment (PPE)

1. Safety glasses
2. Safety boots
3. Safety gloves (for operator)
4. Industrial Hardware Clothing PPE (Reflector ware)

### Tools & Materials Required:

#### Recommended Test Specimens

1. Rock specimen
2. Brick specimen
3. Metal (Steel) specimen

#### Test Specimen Prepared

1. Cylindrical
2. Cubic



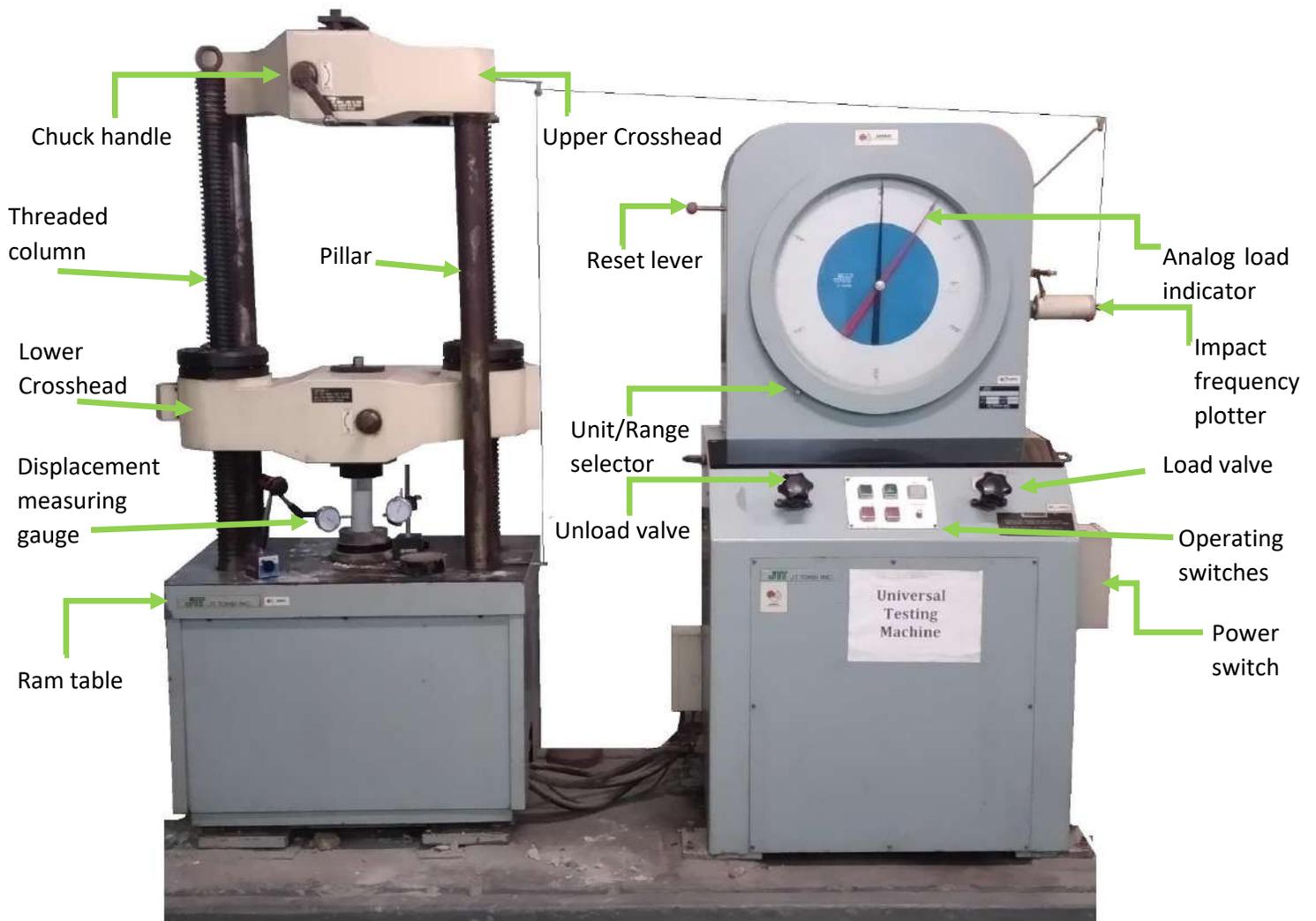
## Specifications

### HYDRAULICS CAPACITY - WEIGHT/LOAD LIMITS

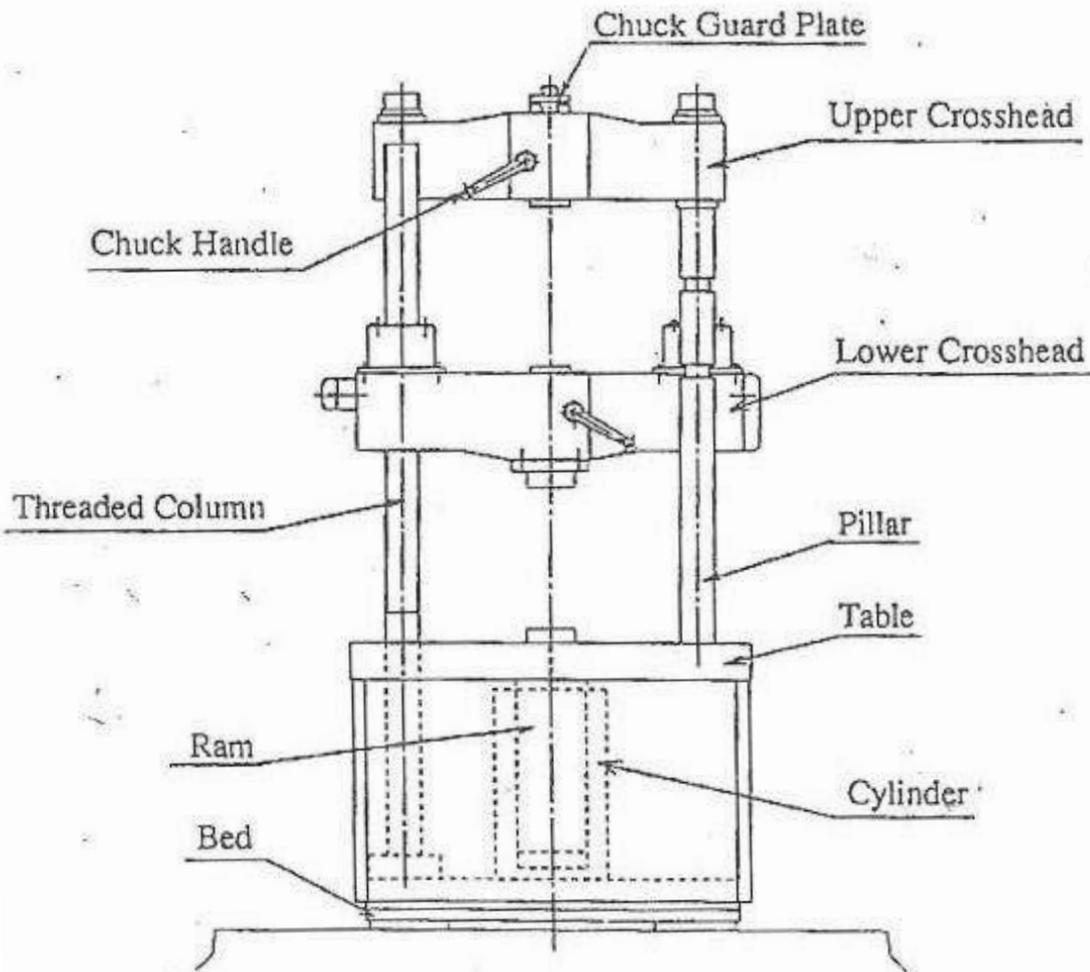
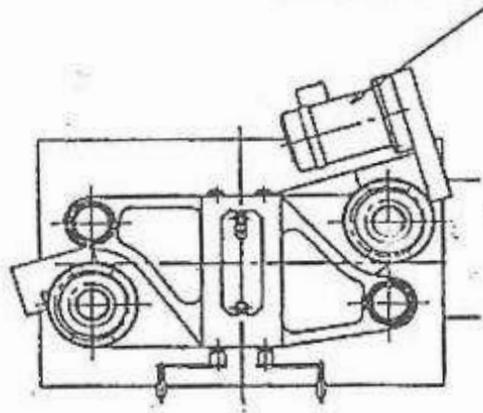
No	Specifications	Capacities
1	Maximum Loading capacity	300 000 N
2	Counter Weight capacity (4 range)	300, 150, 60 & 30 kN
	Minimum graduation	500 , 250, 100, 50 N
3	Divided in	1/600
4	<b>Tensile Test</b>	
	i Maximum Distance between Gripping Heads (with Ram stroke)	800 mm
	ii Gripping for Round Bar (1 set)	∅ 6 – ∅ 40 mm
	iii Gripping for Flat Bar (1 set)	0 – 30 mm width 50 mm
5	<b>Compression Test</b>	
	i Maximum Distance between Compression Plates	0 – 720 mm
	ii Diameter of Compression Plates	∅ 100 mm
6	<b>Transverse Test</b>	
	i Maximum Distance between Supports	500 mm
	ii Support Roller width	150 mm
	iii Support Roller diameter	∅ 30 mm
7	<b>Bending Test (Flexural)</b>	
	i Tip of Bending Punch (radius)	R15 mm
8	Maximum Distance between Columns	500 mm
9	Effective Area of Table	500 x 500 mm
10	Ram Stroke	200 mm
11	Maximum Ram speed (at 50Hz, no load)	approx. 110 mm/min
12	Crosshead elevation speed (at 50Hz)	approx. 350 mm/min
13	Oil-pressure supply motor	3 phase, 4P, 1.5 kW
14	Lower Crosshead elevation motor	3 phase, 4P, 0.4 kW



## Compositions



Motor for Elevating the Crosshead



# SETTING UP

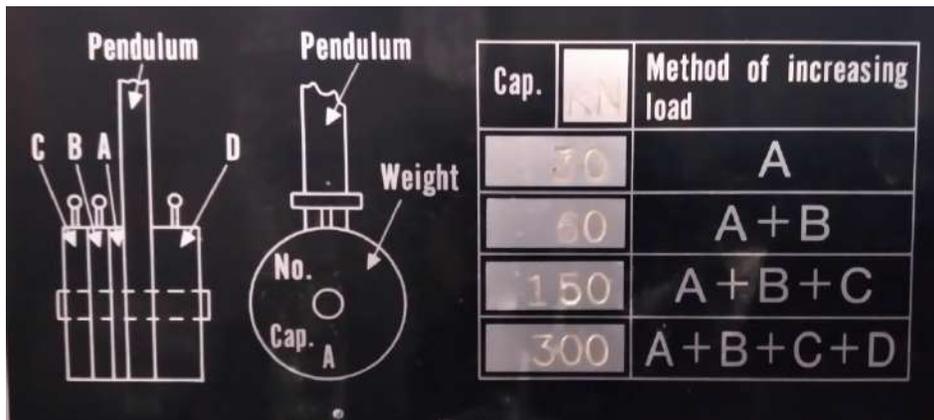
## Setting-Up Procedures

### Preparations for Test

Prior to starting up this equipment and operating this equipment, there are a number of features of this equipments that needs to be set up to appropriate modes before proceeding to operate the equipment;

#### 1) Selection of Load and Scale

For all types of tests the Pendulum weight and scale are selected matching the desired load weighing capacity, according to the strength of the test specimen. For the hardest rocks like quartz and granite are appropriate for maximum counter weights as 300 kN while the moderately hard down to soft rocks like sandstone, mudstone and siltstone should be assigned counter weights in the range of 150 kN down to 60 kN and 30 kN and setting unit range relatively to match the weights. Do not use load within its 20% range, since the accuracy is not guaranteed.



#### 2) Adjust the Unit

Adjust the Unit per division of graduations from the range selector to match the selected counter weights.

No.	Counter Weights	Loads (kN)	Unit Selection (N)
1	A	30	50
2	A + B	60	100
3	A + B + C	150	250
4	A + B + C + D	300	500

#### 3) Zero adjustments of Pointer

The left valve is closed, the right valve is opened gradually so as to ascend the main ram by about 10mm. Then the main ram is stopped by closing the right valve. The Analog Pointer is adjusted to show zero point by turning the rack rod. Turn the Load dial Pointer and Max-load marker dial align to zero.



# OPERATING PROCEDURE

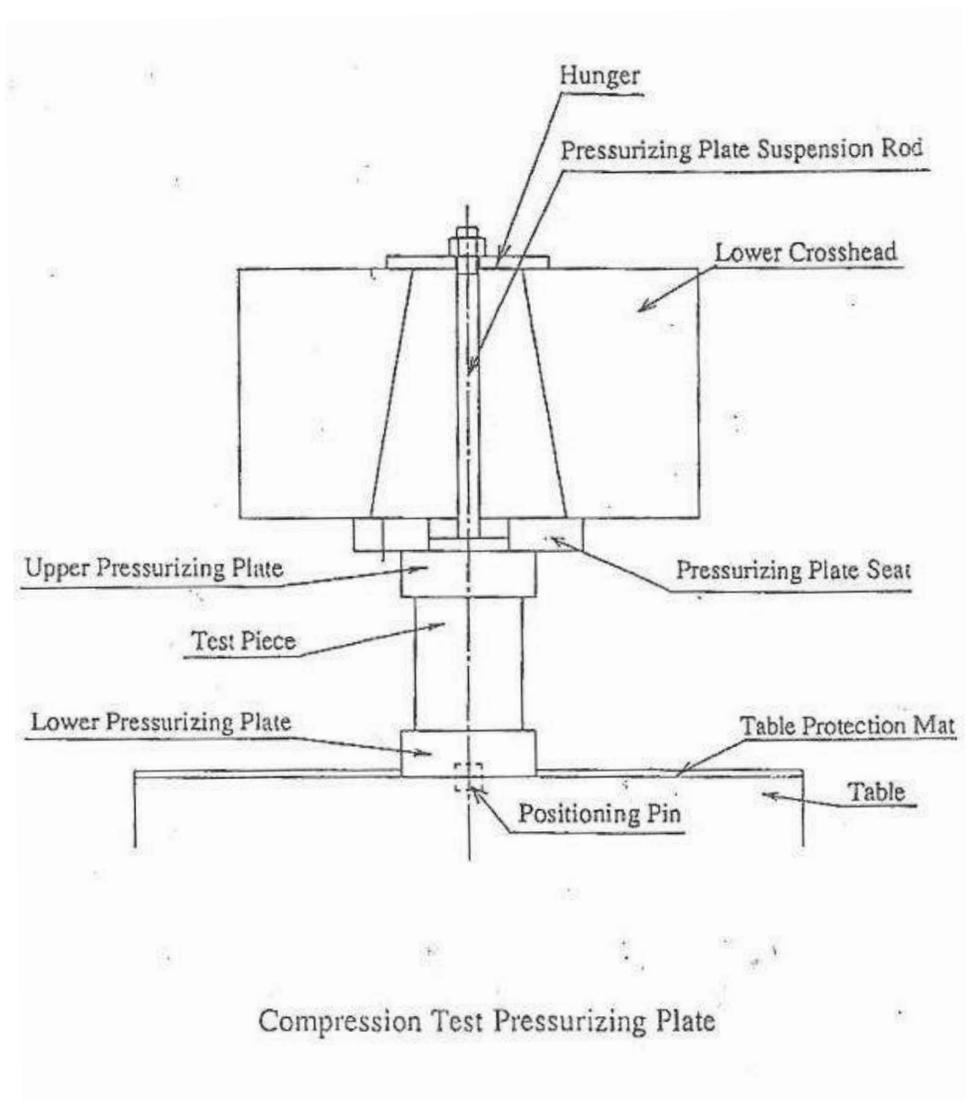
## Operating Procedures

### Compression Test

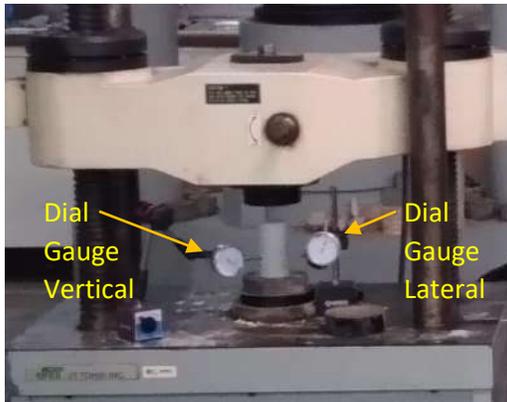
#### Test Jig mounting

For conducting Compression Tests follow the equipment set up procedures below to set up the equipment before proceeding onto actually conducting the experiment on the test specimen;

- i. Position the test specimen under the crosshead, fitted under the upper pressurizing plate and aligned to the center of the lower/ram table top plate



- ii. Lower the Crosshead by operating the Crosshead DOWN [↓] pushbutton switch to get to a reasonable height to allow space for setting up the test specimen under the crosshead. Push the DOWN [↓] pushbutton switch for elevation the crosshead and lower the Lower Crosshead till the gap between the test piece and Upper Pressurizing Plate is reduced to approx. 2 or 3 mm.
- iii. Position the measuring dial gauge into contact position with the specimen and set the dial to zero.
- iv. Set up the dial gauge to the test specimen to measure the deformation of the specimen while it's taking load. Set the pointer of the gauge into contact with the specimen to measure lateral deformation (change in width) and set the dial to zero, and to measure vertical deformation (change in length) set the pointer to the crosshead.



### Operating and conducting compression test

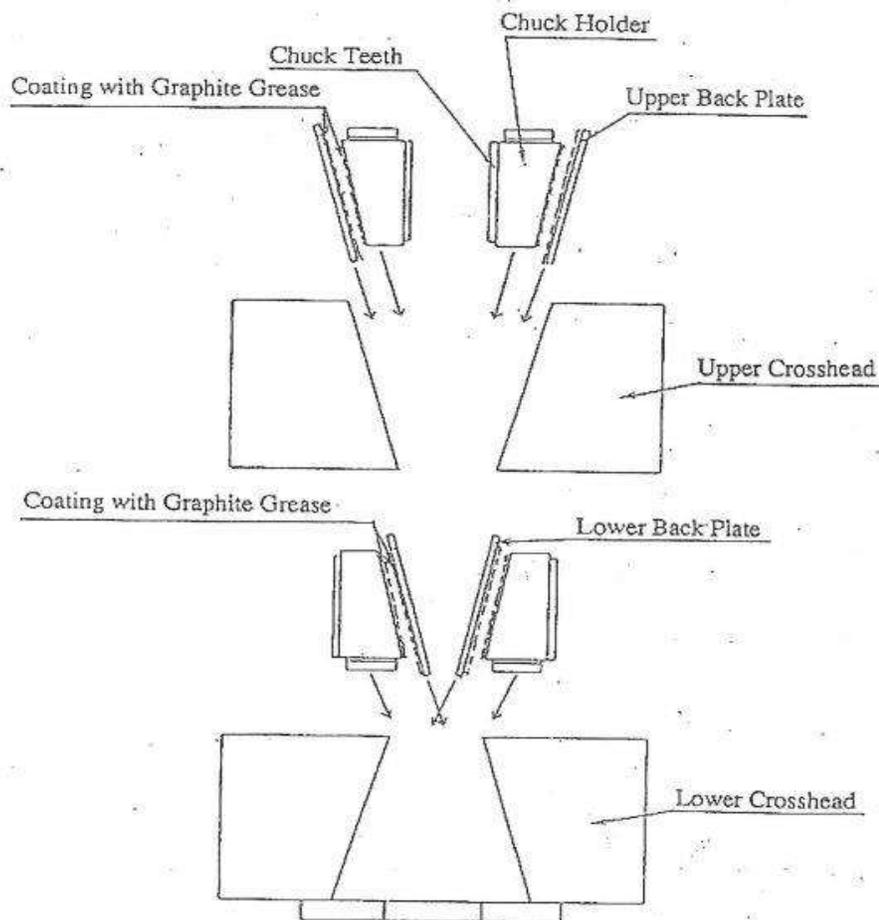
- 1) After setting up the test specimen in position under the crosshead to apply load, switch the pump and set the dynamometer dial to zero reading and ensure the unit selection is set to match load to desired range.
- 2) Start applying load.
  - i. Close the left valve and open the right valve slowly and apply the load carefully while watching the load pointer of the scale plate.
  - ii. Close the right valve and open the left valve, after the test piece breaks. Lower the ram till the ORIGIN position then stop the ram by turning the left valve to close.
- 3) Remove the broken test piece.
- 4) Read the maximum load value (final failure load) from the peak load indicator (*the set pointer*).
- 5) Repeat the procedures, beginning at Step (1) if another compression test is desired.
- 6) Test end
  - i. Close the right valve and open the left valve and lower the ram to the lowest position when finishing the test.
  - ii. Push the PUMP [OFF] pushbutton switch to stop the hydraulic pump.



## Tensile Test

### Test Jig mounting

For conducting Tensile Tests follow the equipment set up procedures below to set up the equipment before proceeding onto actually conducting the experiment on the test specimen;



Directions for Inserting Chuck Holders and Back Plates.

#### A. Upper Crosshead Side

- i. Mount four chuck teeth on the four chuck holders matching the test piece shape (round bar or plate). Mount the Chuck teeth so that the tips of the teeth contact the test piece.
- ii. The stamped marks must be located on this side. (Chuck Holding Plate side)
- iii. Coat the back sides of the chuck holders and the back sides of the Back Plates with Graphite grease.



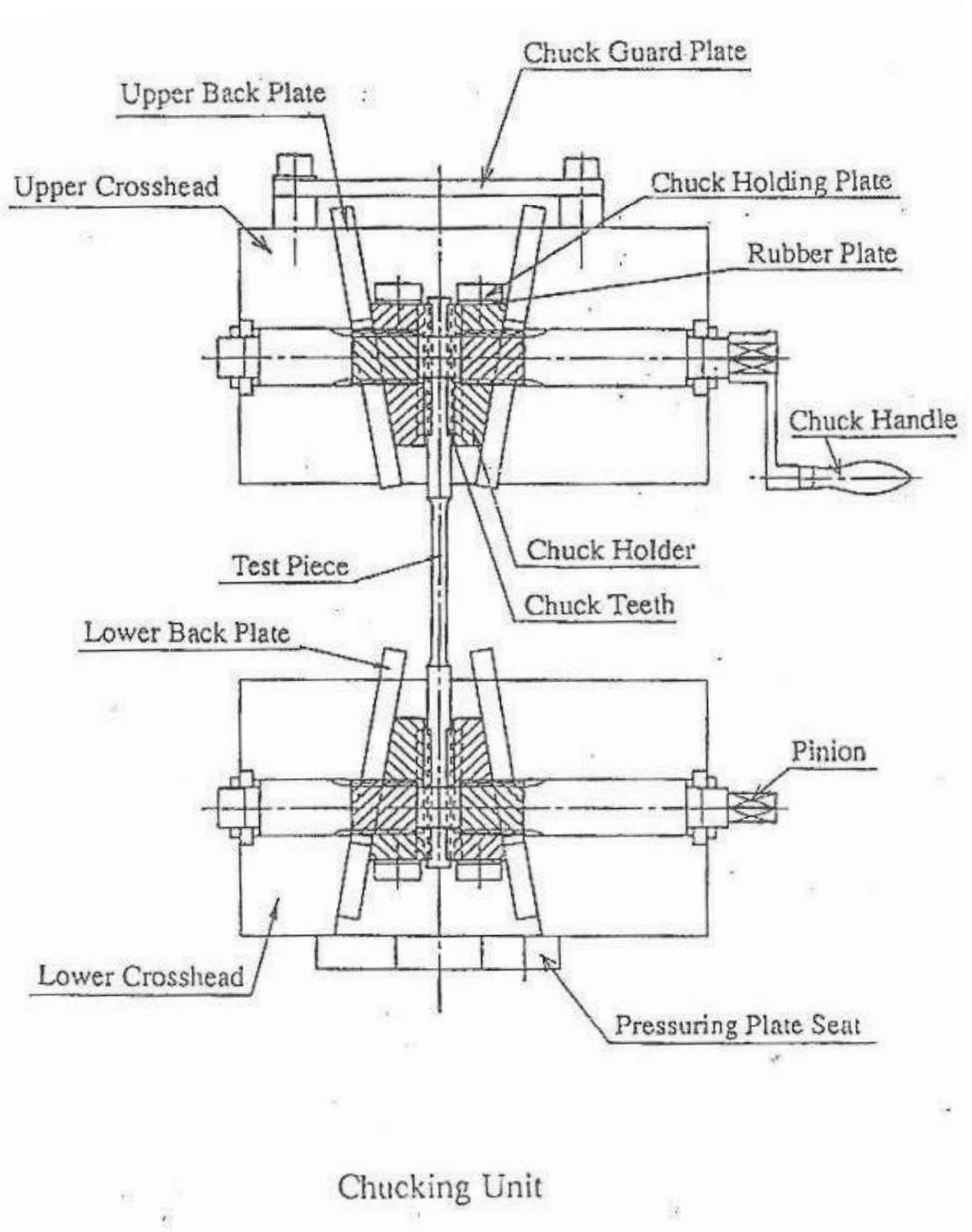
- iv. Mount the chuck handle at the tip of the pinion shaft of the upper crosshead.
- v. Insert the two Back Plates between the Chuck Holders and square hole in accordance with the test piece size. Insert the long Back Plates in the Upper Crosshead. The Back Plates are provided with the notches for sliding down the pinion shaft and with chamfered parts. Insert them carefully, exercising caution as to the inserting direction. The Chamfered parts must contact the corners of the crosshead square hole.
- vi. Insert the Chuck Holder by operating the Chuck handle. If the positions of the left and right Chuck Holders are not aligned, raise the Chuck Holders by operating the Chuck handle, then lower them.
- vii. Mount the Chuck guard plate.

B. Lower Crosshead Side

- i. Mount the Chuck handle at the tip of the pinion shaft of the lower crosshead.
- ii. Insert one of the Chuck Holders into the square hole of the Lower Crosshead from above. Lower the inserted holder by operating the Chuck handle.
- iii. Insert the other Chuck Holder similarly. Rotate the handle and raise the Chuck Holder inserted earlier to the top position to align the two holders.
- iv. Rotate the handle in the opposite direction and lower the two holders. Rotate the handle by a stronger force and provide a gap between the back sides of the holders and square hole of the Crosshead using a screwdriver or tool.
- v. Insert two Back Plates into the gap corresponding to the size of the test piece. Use short Back Plates for Lower Crosshead.
  - 1) When removing the lower holder, remove the two Back Plates. Raise the holders by operating the handle. Lower one holder by operating the handle while holding the other holder. Remove the held holder. Raise the remaining holder again by operating the handle and remove it.
  - 2) Use of Back Plates



## Operating and conducting Tensile test



### 1. Setting Test Piece

Insert the test piece into the Chuck teeth of the Upper Crosshead and fix it tightly by operating the Chuck Handle. Remove the handle after setting the test piece. Check that the ram is now positioned in the ram origin.

### 2. Canceling empty weights of test jigs and test piece.

Perform Zero adjustment of the load indication again in the minimum load range.



3. Adjusting the Lower Crosshead position  
Push the UP [↑] pushbutton switch for elevating the Crosshead and raise the lower Crosshead till the test piece can be chucked by the chucking teeth of the Lower Crosshead. Check that the chuck teeth are open.
4. Start applying the load:
  - 1) Close the left valve and open the right valve slowly and tighten the Lower Chuck Handle securely.
  - 2) Further apply the load while watching the load pointer. Hold the Lower Handle till the load reaches approx. 5% of the weighing capacity, as a criterion. Remove the lower handle once this position is passed.
  - 3) Rotate the load control knob further toward "OPEN" and apply the load carefully, watching the load pointer.
    - i. The load pointer rotates in the opposite direction (counter-clockwise) when the yield point appears. The value of the peak load indicator (the set pointer) at this time is the yielding load value.
    - ii. After passing the yield point, the load rises again.
    - iii. The load lowers after it reaches the maximum load and the load pointer starts rotating in the reverse direction again. The test piece breaks, is cut with a bumping tone and the lower part of the test piece drops on to the table. The value of the peak load indicator (the set pointer) at this time is the maximum load. The top surface of the table may be damaged by the dropping test piece fragments. Put a suitable receiving pan under the test piece, to collect the fragments.
5. Stop the ram by turning the right valve to close when the test piece breaks.  
Caution: Unless the right valve is closed, the ram rises further. This is dangerous
6. Removing Test Piece  
Mount the Chuck handle at the tip of the pinion shaft. Holding the test piece with one hand, rotate the handle counterclockwise and remove the test piece.
7. Resetting Ram to Origin  
Close the right valve and open the left valve, the ram will go down.
8. Read the maximum load value from the peak load indicator (the set pointer)
9. Repeat the procedure beginning at Step (1) if another tension test is desired.
10. Test end.
  - i. Close the right valve and open the left valve and lower the ram to the lowest position when finishing the test. (Unless the ram is lowered, the initial load is always applied to the pressure cell. If this condition is allowed to remain for a long time, the characteristics of the pressure cell may be damaged).
  - ii. Push the 'PUMP' [OFF] pushbutton switch to stop the hydraulic pump.



## Transverse and Bending (Flexural) Test

### Test Jig mounting

For conducting Transverse and Bending Tests follow the equipment set up procedures below to set up the equipment before proceeding onto actually conducting the experiment on the test specimen;

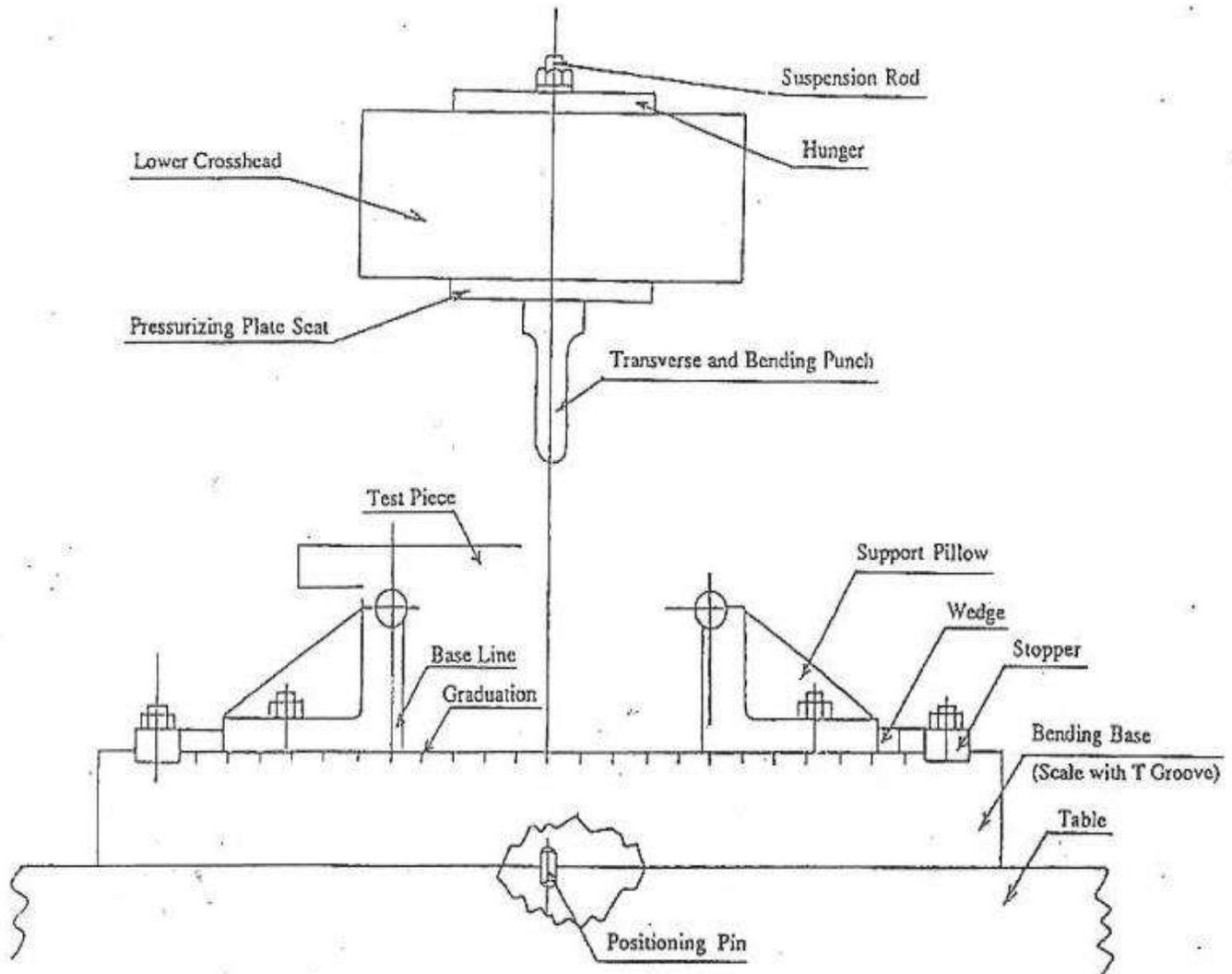
- i. Insert the positioning pin the hole located in the center of the bottom of the bending Base. Place the Bending Base, aligning the pin and the hole in the center of the table.
- ii. Mount the traverse and bending punches by the same method as that for the Upper Pressurizing Plate.

Back Plate Type	100, 200, 300kN	
	10, 20, 30 ft	
	Rod	Plate
Back Plate (Thick)	6 - 22	0 - 15
Back Plate (Thin)	22 - 40	15 - 30



## Operating and conducting bending/flexural test

(Conforms to JIS Z 2248 – Method of Bend Tests for metallic materials)



Transverse and Bending Test Equipment

- 1) Setting test pieces  
Place the test piece correctly in the center of the transverse and bending test equipment fulcrum roller, using the scribed line as a criterion
- 2) Cancelling empty weights of test piece and jigs.  
Perform Zero adjustment of the load indication again in the minimum load range.



- 3) Adjusting Lower Crosshead position  
Push the DOWN [↓] pushbutton switch for elevating the crosshead and lower the Lower Crosshead till the gap between the test piece and Upper Pressurizing Plate is reduced to approx. 2 or 3 mm.  
Exercise caution to avoid contact between the test piece and tip of the punch.
- 4) Start applying load.
  - i. Close the left valve and open the right valve slowly and apply the load carefully while watching the load pointer of the scale plate.
  - ii. Close the right valve and stop applying the load when the bend angle of the test piece reaches approx. 170
  - iii. Close the right valve and open the left valve, and lower the ram till the ORIGIN position then stop the ram by turning the left valve to close.
  - iv. Remove the test piece and the transverse and bending test equipment. Mount the compression-test pressurizing plates on the table and lower the Crosshead.
  - v. Insert a shim with a thickness twice (2r) the inside radius of the inside of the bent test piece into the inside of the bent test piece and put them on the lower pressurizing plate.
  - vi. Apply the load till the test piece is bent 180 by the same method/procedures as that for compression tests.
  - vii. Close the right valve and open the left valve immediately when the test piece is bent 180 and lower the ram till the ORIGIN position, then stop the ram by turning the left valve to close.
- 5) Remove test piece and check for external bursts on the bent part and other defects.
- 6) Repeat the procedure beginning at Step (1) if another bending test is desired.
- 7) Test end
  - i. Close the right valve and open the left valve and lower the ram to the lowest position when finishing the test.
  - ii. Push the PUMP [OFF] pushbutton switch to stop the hydraulic pump.

