Technical Information

MPM 8000 Series Charpy/Izod/Tensile Plastic/Metal Pendulum Impact Test Machine and Peripheral Equipment

MP Machinery and Testing, LLC (MPM) is pleased to provide this information package in response to your request for impact test machine information. MPM strongly recommends that the capacity of the test machine be at least twice that of the material being tested to ensure that the velocity decrease during impact is not significant. The MPM 8000 is a variable capacity table top model (2 J to 67 J), and this machine has been designed so that weights or additional pendulums can be attached to the machine to increase or decrease the test capacity as needed (see Figure 1). Since the MPM machine uses optical encoder technology to measure the absorbed energy to within about one encoder count 0.007 J (0.005 ft-lbs), the capacity of the test machine does not significantly affect the accuracy of the measurement. Therefore, increasing the energy capacity does not affect the resolution of the measurement in any significant way.

In addition to the test machine description, a discussion of several test machine options has been provided which you may wish to consider. Any of the options discussed here can be easily added later because the test machine has been designed to accommodate the upgrades. The test machine and proposed options are described below.

8000 Series Test Machine Description

Although the machine is widely used to test plastic and ceramic materials, the robust structural and pendulum design makes the machine well suited for metal specimens as well such as those used in the Miniaturized Charpy V-Notch (MCVN) test. The test machine measures the energy absorbed in fracturing a test specimen using an optical encoder with 20,000 divisions per revolution. This is one of the finest division encoders ever used in Charpy testing and is capable of resolving energy to within about 0.003 J (0.002 ft-lbs) (1 encoder division). Since the encoder accuracy is so high, MPM does not provide a dial indicator with the test machine. Experience at MPM has shown that it is not possible to resolve the dial indicator to within better than about 0.27 J (0.2 ft-lbs). The encoder data is acquired by the Impact™ v6.1 software and used to determine the absorbed energy by calculating the height of the striker contact point before release and the maximum height attained after impact. In addition, the velocity of the striker is recorded from release up to the impact event. Therefore, the exact velocity at impact is recorded in the test record for each test. The software provides a printed test record which includes key information such as the test specimen ID, the date of the test, name of operator, test temperature, impact velocity, measured energy, etc.. The software also has a statistical calculation capability for standard deviation and average calculation of key parameters.

Another important benefit associated with the encoder technology is that the windage and friction correction is much more accurate than can be achieved using a dial. The MPM system automatically corrects for windage and friction on every test. For the MPM system, a free swing is performed to determine the windage and friction correction without a test specimen. During an actual test, the software applies the correction only to the height of the swing after specimen impact. The program contains a geometric function which properly scales the correction. The encoder is repeatable to within one division which means that the windage and friction correction uncertainty is less than about 0.003 J (0.002 ft-lbs) for the 1 pound pseudo mass pendulum.

Data Acquisition

A data acquisition computer is used to record the encoder energy and the optional instrumented striker voltage-time signal. For data acquisition without a computer, an On-Machine data acquisition system can be provided. MPM will provide the data acquisition system along with hardware installation, software configuration, and calibration.

A photograph of the data acquisition computer is given in Figure 2. The system includes an optical encoder for energy measurement, a strain gage amplifier (only included with instrumented striker system option), a 12 bit fast acquisition oscilloscope board (only included with instrumented striker system option), and the data acquisition software. The dynamic amplifier is an excellent research laboratory tool. The amplifier provides autobalance, amplifier range selection over several decades, and shunt calibration for periodic calibration checking.

Continuous Velocity Adjustment (Low Blow Fixture)

The test machine design incorporates a continuous hammer release height adjustment. Some manufacturers refer to this as a “low-blow” fixture. Adjusting the hammer release height enables testing at velocities from 0 to 11.3 ft/s ($v = (2gh)^{0.5}$, where v is the impact velocity, g is the gravitational constant, and h is the release height). Of course the potential energy (PE) also varies with drop height ($PE = Wh$, where W is the pseudo mass weight). The software has an equation to determine the local gravitational constant based on elevation above sea level and latitude. While the analytical equation can be used to determine the impact velocity, in most cases it is best to let the MPM optical encoder make the measurement on every test.

In order to adjust the release height, the user must loosen the two latches holding the pendulum to the angle disc. These latches are located on the back face of the pendulum, and can be loosened using an allen key. Once loosened, the pendulum can be rotated to a new angle of release position on the angle disc and re-tightened. Using the markings on the angle disc, the user can select any latch angle from 0 degrees to the maximum angle (180 degrees) by lining up the line on the pendulum with the desired angle on the angle disc. Adjusting this angle changes the drop height, which allows for tests at different velocities. Figure 3 shows an example of setting the desired angle, while Figure 4 shows the latches that must be loosened to change the angle.

Base Installation

MPM strongly recommends that the test machine base plate be securely bolted to a massive base that will prevent any movement of the machine during impact. Movement of the base during a test will result in incorrect data. If it is desired to install a concrete base, MPM offers a full service installation option or the use of a Charpy machine base installation kit, phone/Email support, and written procedures to assist customers in setting up their machine for the first time.

In addition, MPM offers a massive steel table which can be securely bolted to the floor. Incorrectly installing the test machine base may cause the base to shift during tests. If this occurs, then any acquired data would be incorrect. It is very important that the test machine base be securely fixed in place.

The holes in the base of the MPM machine match the holes of some other test machine manufacturers. So, if you are upgrading from a previous machine, it is likely that MPM can match the current bolt hole pattern.

Izod Clamping Fixture

The test machine can be easily set up for Izod testing. The setup involves installing the Izod striker and the Izod clamping fixture on the test machine base block. MPM offers either a manual Izod clamp (hand tightening knob) or a pneumatic clamp for rapid specimen fixturing. Figure 5 shows both the pneumatic clamp and the hand tightening knob. The pneumatic clamp is removable, and can be replaced by the hand tightening knob. The pneumatic clamp has the advantage that the clamping force is adjustable and repeatable from test-to-test.

Since the pendulum is set in a fixed swing path, the Izod clamping fixture must first be centered and aligned on the machine. To do this, use the following procedure.

1. Place the fixture on the machine using the left edge of the fixture base as a reference surface by pushing it against the base.
2. Center the specimen centering anvil in the Izod fixture for a "zero thickness" specimen as follows:
    a. Measure the thickness of the anvil/specimen centering block (the small block between the fixed vice grip and the movable vice grip).
    b. Measure the thickness of the clamping fixture.
    c. Divide the clamping fixture thickness by 2, and subtract the centering block thickness.
    d. From the front of the test machine, measure the depth to the centering block (Figure 6).
    e. Move the centering block by loosening the allen key on the left side of the fixture so that block is in position for a zero thickness specimen.

    f. Tighten the allen key screw to fix the centering block anvil position.
3. Insert the MPM Centering Tool into the fixture (Figure 7)
4. Slide the fixture until the tool just touches the side of the striker while maintaining alignment with the from reference edge.
5. Screw down the 4 screws to connect the fixture to the base at the specified torque.

After the fixture is properly attached to the machine, the centering block can be adjusted for specimens of different thicknesses. To do this, measure the depth to the anvil/centering block from the front face of the Izod fixture. Then simply subtract half of the specimen thickness, and move the centering block to this depth. It may be useful to record these depths for standard specimen thicknesses.

To use the pneumatic clamp for Izod testing, the clamp must be correctly connected to the machine and the switch on the left hand side of the machine column must be set to “IZOD.” After these are set, the user can use the clamp switch located on the front of the base of the machine. The clamping pressure can then be set by the pressure regulator on the column of the machine. The pressure regulator is powered by a 9-Volt battery. When set to “UNCLAMP,” the clamp pressure is set to 0 psig and both the centering tool and pneumatic clamp are retracted, allowing for the user to insert the specimen. When set to “CLAMP,” the system will clamp the specimen into place at the pressure set by the regulator on the side of the machine column. Enough pressure should be applied so that the specimen is firmly held in place by the clamp. Note that the pressure can only be set using the regulator when the specimen is clamped. The pressure will read 0 psig when unclamped.

Once the specimen is placed at approximately the correct position against the fixed vise jaw and centering block, the clamp switch can be turned to “CLAMP.” Then the following events occur:

1. The notch centering tool extends out and into the notch. The specimen may need to be adjusted up or down to allow the tool to enter into the notch.
2. The movable vise jaw then clamps the specimen into place.
3. The centering tool retracts in preparation for the impact event.
4. The release button is then enabled for release (it is disabled any time the centering tool is extended).
5.

This sequence occurs in fairly rapid succession automatically.

Charpy Fixture

Like the Izod Clamping Fixture, the Charpy fixture must also be centered on the machine since the pendulum has a fixed swing path. MPM offers a Charpy centering tool which is used to center this fixture. Figure 8 shows the centering tool being used. First place the fixture on the machine, again using the left edge of the fixture as a reference surface by pushing it against this surface. Then put the centering tool on the fixture and rotate the striker slowly in until the striker enters the slot. With the striker in the slot, screw the fixture into place and remove the centering tool. Be sure the Charpy base is up against the reference surface as the bolts are tightened.

The Charpy fixture also requires the height of the supports to be adjusted so that the center of the test specimen is at the center-of-striker (12.8 inches for most machines). First loosen the adjustable set screw on the right side of the Charpy fixture. Using digital calipers set the height of the supports above the base plate should be the value reported in the calibration report for a 0.5 inch thick specimen. This value should be close to 2.763 inches for a 0.5 inch thick specimen. For specimens smaller than 0.5 inches thick, simply move the supports up by a distance equal to half of the specimen height. The supports are factory set at the height for a 0.5 inch thick specimen prior to shipment.

To place a specimen on the Charpy fixture, MPM provides a Charpy Specimen Centering tool. This tool fits between the supports and has a protrusion which should enter the Charpy notch for precise centering. With the tool against the test specimen and between the anvils, simply remove the tool out of the left side of the fixture, keeping the specimen in place. This process is illustrated in Figure 9.

Pendulum Weights

Figure 10 shows the pendulum with the essential weights attached to provide a nominal 1 pound pseudo mass. These weights bring the baseline pseudo-mass of the pendulum to ~1.0 lb and must always be on the pendulum. DO NOT REMOVE THESE WEIGHTS FROM THE PENDULUM. More weight can be added to increase the pseudo-mass in order to increase the energy capacity of the test machine. Typical extra weight plates can be seen in Figure 11. MPM can provide any weights desired to achieve energies capacities up to 67 J.

Striker Installation

The Charpy or Izod striker is held on by two bolts which go through the arc of the pendulum. To install the Charpy striker, place the striker firmly against the arc surface and firmly towards the leading edge of the pendulum, then tighten the two bolts. The distance from the bottom of the arc to the bottom of the striker should be 1.25 inches for the Charpy striker. Tighten to the specified torque.

For the Izod striker, the MPM Izod striker height gage should be used. Figure 12 shows the correct use of the MPM Izod striker gage. This tool sits on top of the fixed vice jaw. When the Izod striker is at its lowest, it should be just touching the MPM Izod striker gage. When at this height, the Izod striker can be screwed into the pendulum just like the Charpy striker described above. The distance from the pendulum arc to the bottom most point of the Izod striker should be 0.831 inches. This will produce a center-of-striker of 12.8 inches and an Izod specimen impact height from the notch to the strike point of 0.866 inches. A photograph of of the MPM Izod striker height gage can be found in Figure 12.

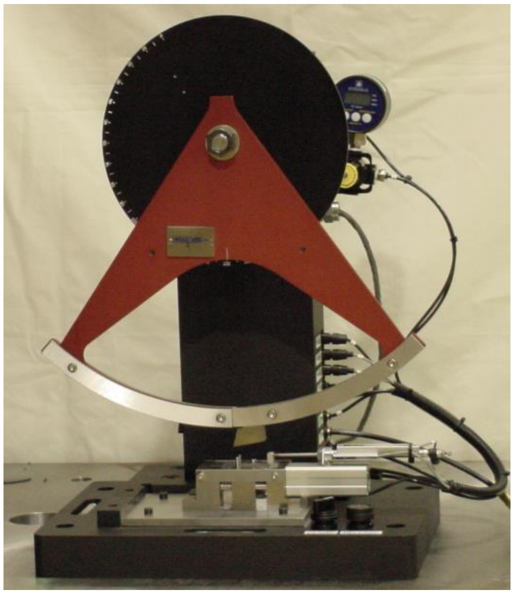

Figure 1 **Table top plastic test machine for Izod, Charpy, and dynamic tensile testing.**

Figure 2 **Data acquisition computer with 12 fast acquisition board, encoder board, encoder hardware, and strain gage amplifier. The amplifier provides autobalance, amplifier range selection, and shunt calibration for periodic calibration checking. The amplifier is capable of a wide range of amplification settings for the research environment needs.**

Figure 3 **Close up of the latch angle being set for 151 degrees.**

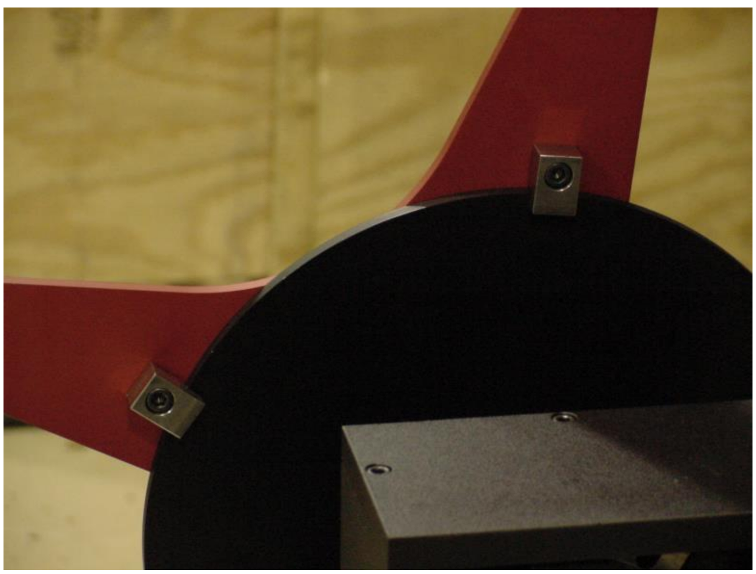

Figure 4 **This picture shows the latches holding the pendulum onto the angle disc. These must be loosened in order to change the latch angle of the pendulum.**

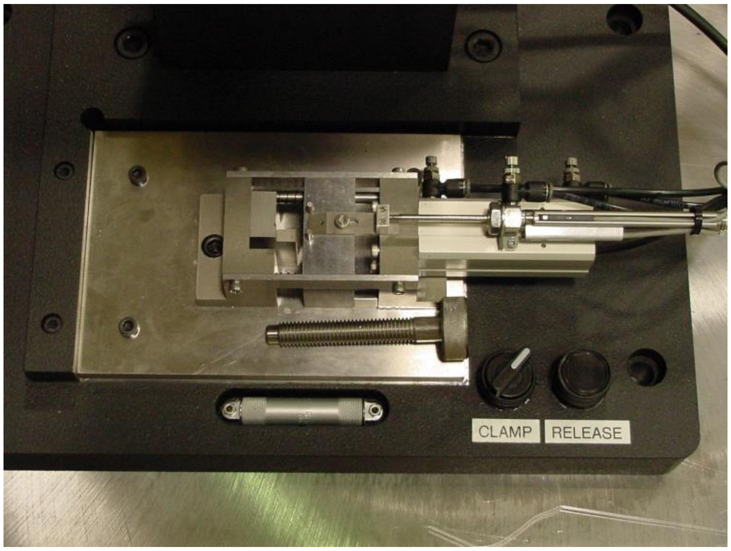

Figure 5 **The pneumatic clamp, as well as the hand tightening knob for the Izod fixture. The pneumatic clamp can be removed and the hand tightening knob can be inserted to manually control the clamp pressure.**

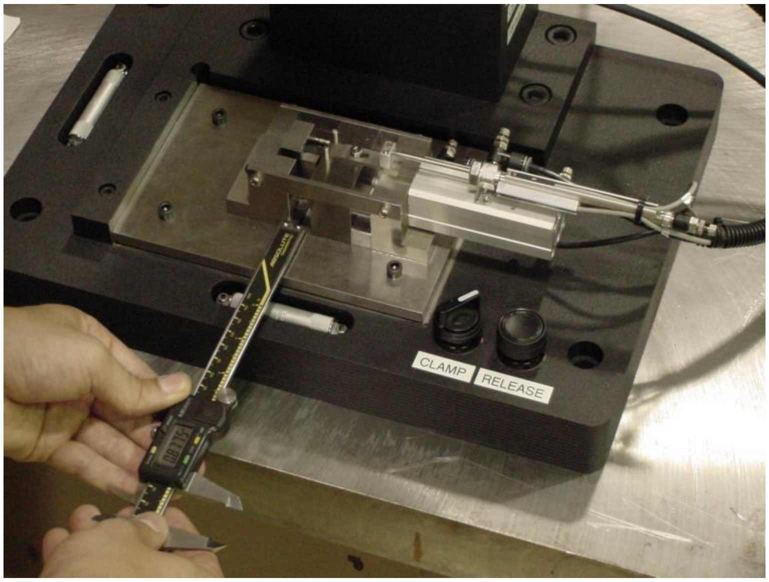

Figure 6 **These digital calipers are being used to measure the depth from the front face of the Izod fixture to the calibration block.**

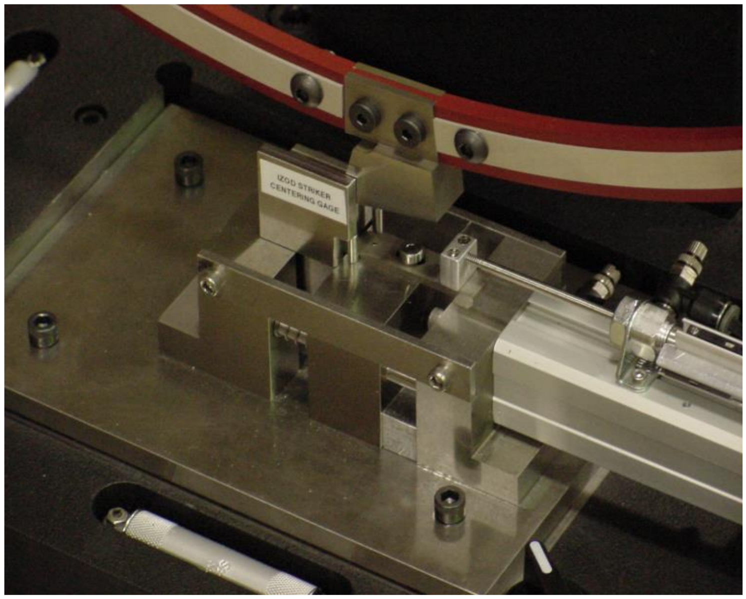

Figure 7 **This shows the Izod centering tool placed in the fixture. The fixture is pushed in until the tool touches the striker to center the calibration block.**

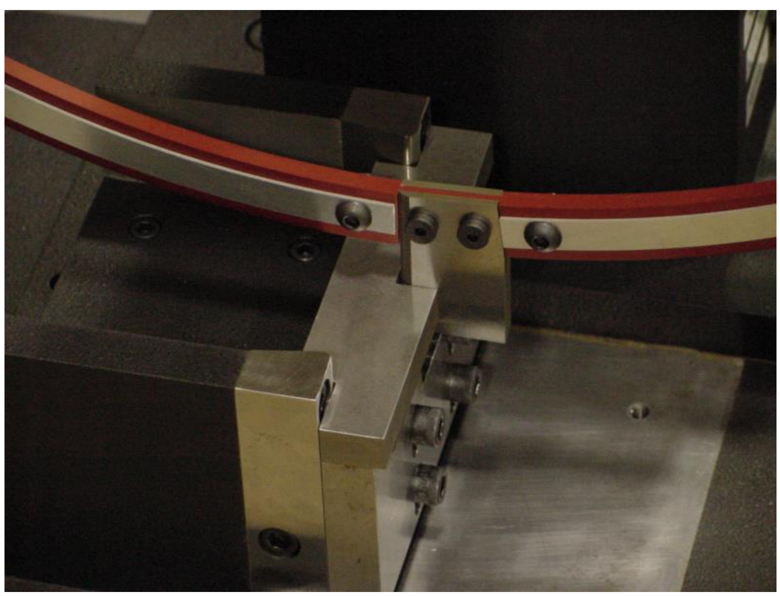

Figure 8 **This shows the Charpy centering tool placed in the fixture. The fixture is moved until the striker enters the slot, then the fixture is bolted down.**

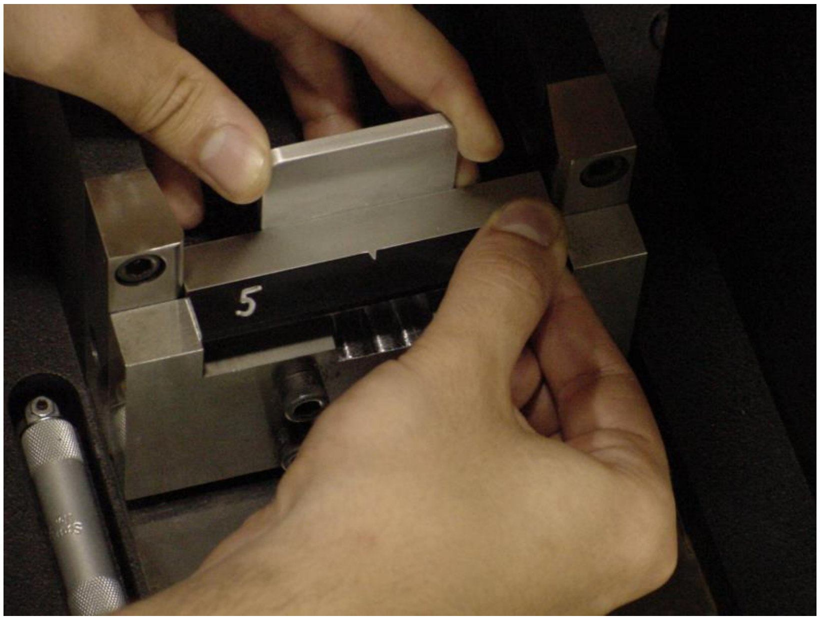

Figure 9 **This shows the Charpy Specimen Centering Gage. Notice how the silver notch of the tool enters the notch cutout in the black plastic specimen.**

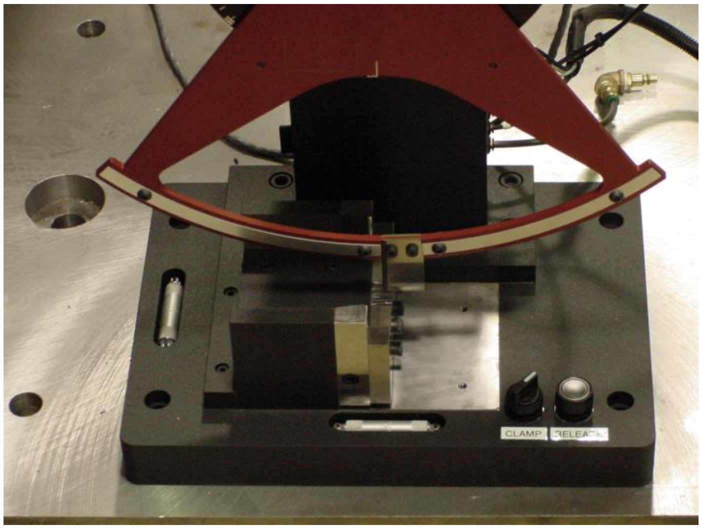

Figure 10 **This shows the pendulum with the essential weight plates added. These plates bring the pseudo-mass to 1.0 lb and must NOT be removed from the pendulum.**

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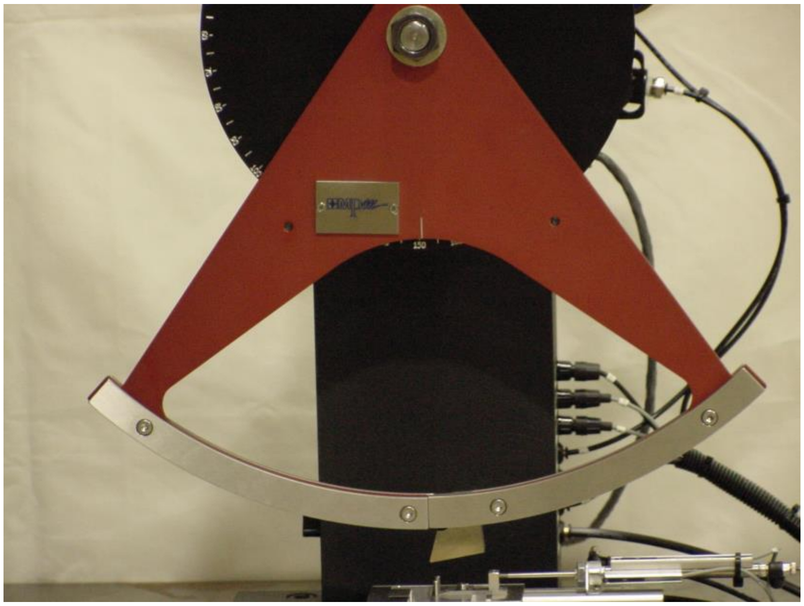

Figure 11 This shows the pendulum with additional weight added to the pendulum.

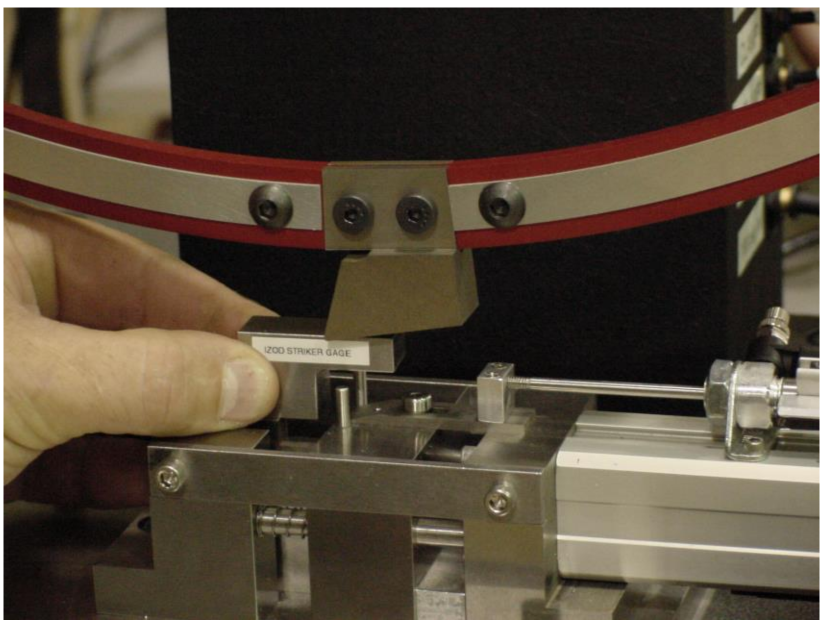

Figure 12 Izod striker height gage.