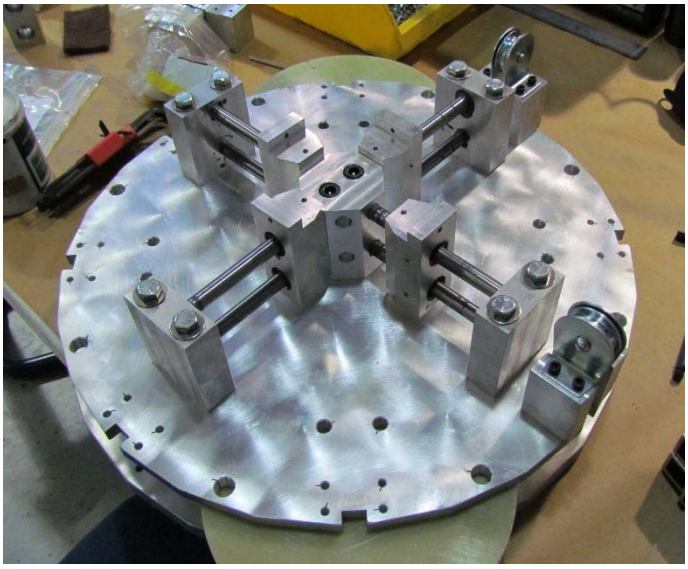

OPERATIONS MANUAL

Ben Hainsey, Nicole Walsh, Eric Hebner

GROUP 2 – BIAXIAL TEST FIXTURE

The purpose of this manual is to provide a template to what our final operations manual, given to our sponsor, will be. Several sections will be filled in when more information surfaces

Sponsor: Cummins (Terry Shaw)
Faculty Adviser: Dr. William Oates
Graduate Consultant: Parker Harwood

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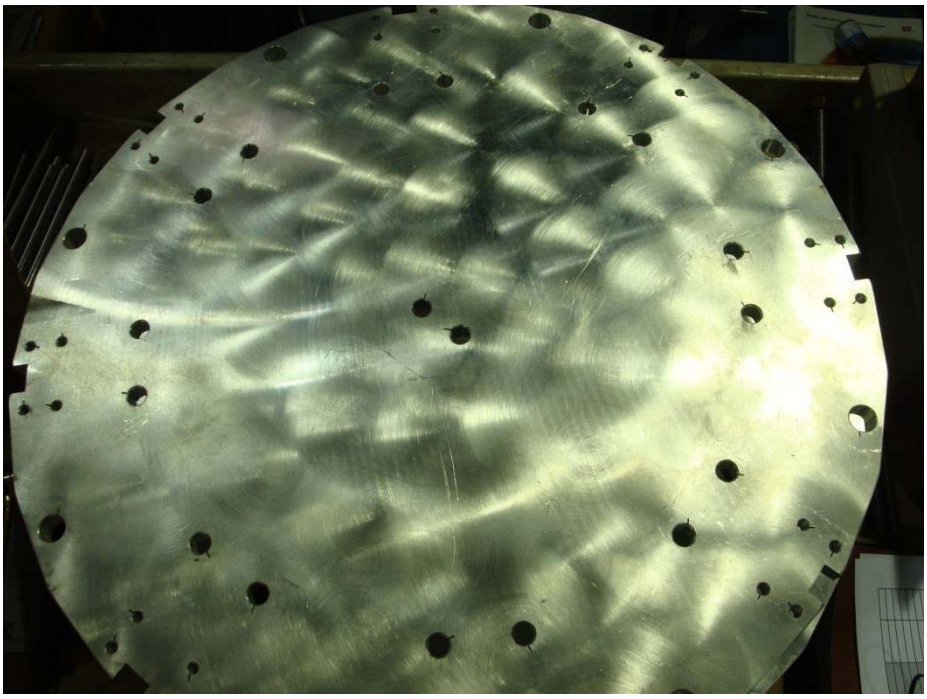
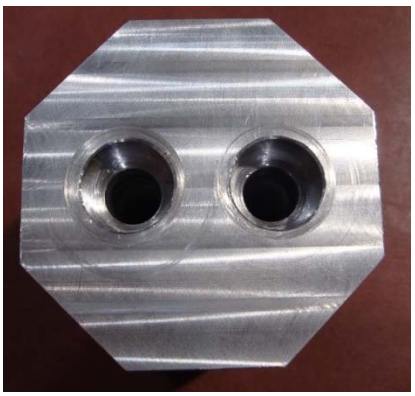
1.0 Function analysis (Nicole)



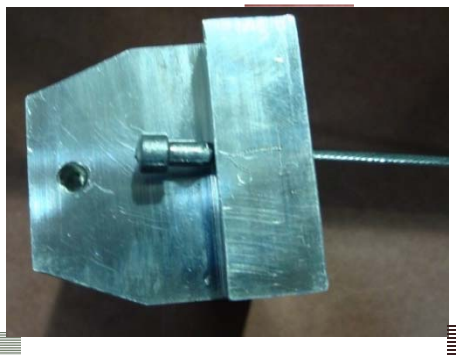
Baseplate

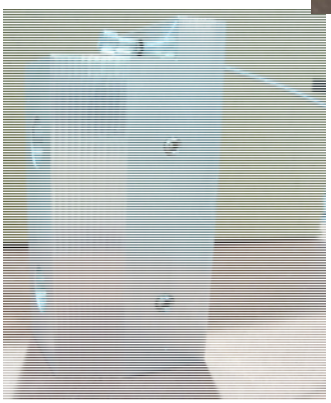


Center Support

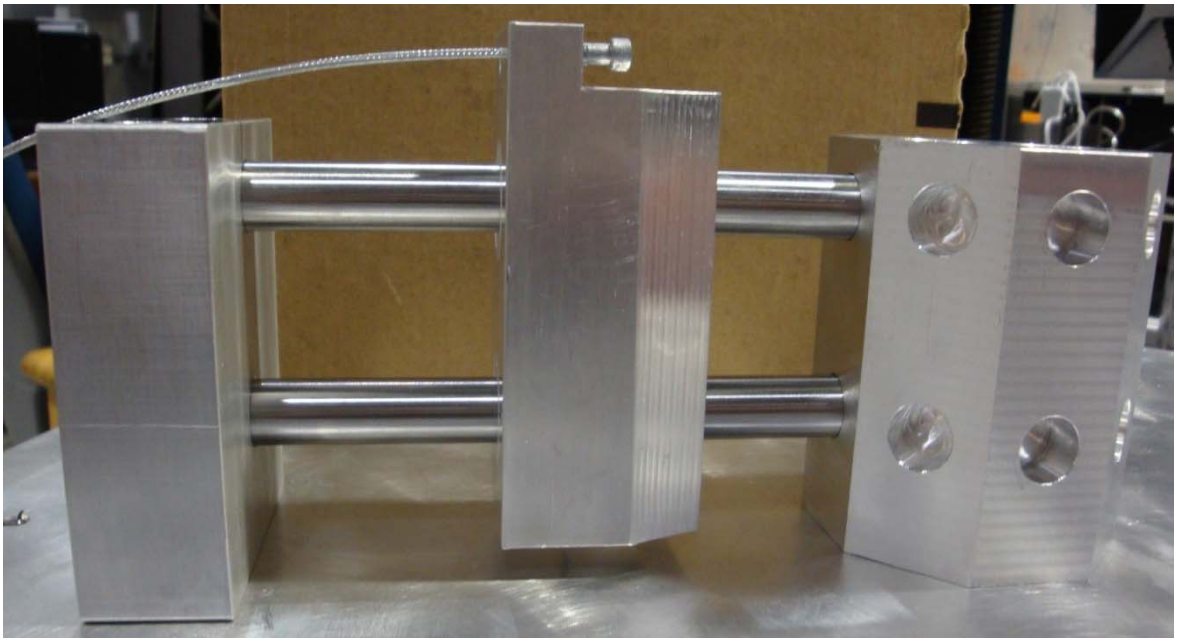
Pulley

Wire Rope End





Carrier(x8)



Carrier support

2.0 Product Specifications

This machine is rated for 500 lbs of force in each of the radial directions. This means that total load of the single MTS load cell is 4000 lbs. The bike cables have been tested and found that fracture occurs at 700 lbs which is well beyond our load rating. The baseplates were analyzed using a beam method to ensure that they can handle the load capacity. As well as, the shear area for each of the carriers was determined to be will within our operating parameters.

Each component that will have a substantial force applied during the testing procedure has been analyzed. However, Plexiglas sides will be in place around the MTS. This is to ensure that worst case scenario occurs then the people operating the machine will be safe.

3.0 Instructions on standard procedure for operation:

3.1 MTS Integration Procedure

Step 1: Assemble biaxial test fixture.

Step 2: Raise the MTS piston to its maximum height.

Step 3: Position MTS crosshead so that the distance between the piston and load cell is between X and Y mm.

Step 4: Secure the top and bottom plates to the load cell and piston of the MTS machine main.

Step 5: Use the provided alignment template to ensure that all middle plate components are in proper position.

Step 6: Double check ALL bolts to ensure that they are properly tightened.

Step 7: Integrate video extensometer.

3.2 Test Sample Preparation Procedure

Step 1: Place material to be tested on a solid wood surface.

Step 2: Place rule die on top of sample.

Step 3: Strike die with a rubber mallet to create sample shape.

Step 4: Lay provided stencil on top of sample.

Step 5: Apply provided marking solution to the sample.

3.3 Test Setup Procedure

Step 1: Use provided template to check alignment of components on middle plate.

Step 2: Raise each cable end to a height that allows the carrier to move all the way to the center by lowering the cable end nuts. Take care not to twist the cable ends.

Step 3: Remove clamping screws and blocks.

Step 4: Position all carriers in the center of the fixture.

Step 5: Attach test sample to carriers in a star pattern (i.e. 1,4,6,3,7,2,8,5) by holding tab hole over clamp hole, insert screw through clamp block and test sample alignment hole, start screw into carrier but do not tighten. After all clamp screws have been started, torque to X in-lbs. in opposite order of initial insertion (i.e. 5,8,2,7,3,6,4,1).

Step 6: Raise the top cable end nuts in a star pattern until each of the cable ends hang freely. Take care not to twist the cable ends.

Step 7: Finger tighten the lower cable end nuts up to the middle plate in a star pattern making sure that the cable end does not twist.

3.4 Test Run Procedure

Step 1: Open the MTS software of your choice.

Step 2: Program the required strain rate, found experimentally, for the desired material.

Step 3: Run test program.

Step 4: Observe the behavior of the sample, if the circular markings close to the center stay circular a valid test is being performed. If the circular markings in the center become irregular proceed to trouble shooting section.

Step 5: Stop test program at sample failure or a maximum strain of X mm.

Step 6: Return to start point.

Step 7: Loosen bottom nuts of the cable tie ends. Take care not to twist cables.

Step 8: Tighten top nuts of cable tie ends down to middle plate until there is slack in all cables. Take care not to twist cables.

Step 9: Remove clamping screws/blocks and the sample.

3.5 Data Analysis Procedure

Data analysis should be done in a Cummins-provided program specifically for determining biaxial data.

3.6 Steps for shutdown

Step 1: Remove sample from test machine.

Step 2: Close MTS program.

4.0 Troubleshooting

4.1 Most Common Sources of Error

- Anisotropic material.
- Dirty moving components.
- Misalignment.
- Slip at grips.
- Pulleys.
- Cable ends.
- Bushings.

4.2 Possible Causes and Solutions

4.2.1 Anisotropic Material

Run uniaxial tension tests on the material being tested on samples perpendicular to each other. If the material has different stress-strain relationships at different orientations, then the analysis presented in this manual are not valid.

4.2.2 Dirty Moving Components

1. When device is not in use store in a clean, dry area.
2. Clean rods and pulley with XXXXX.
3. Clean carrier bushings with XXXXX.

4.2.3 Misalignment

Use the provided alignment template before each test to ensure that the components on the middle plate are all properly aligned. Make sure that all bolts are tightened to proper specifications as outlined in section X.X.

4.2.4 Slip at Grips

Step 1: Inspect sample's alignment holes for evidence of pulling by clamp screw.

Step 2: If hole is elongated rerun test, increasing the torque on clamp screw to XX ft-lbs.

Step 3: Re-inspect alignment hole.

Step 4: If sample fails at end of grip reduce torque on clamp screw to XX ft-lbs.

4.2.5 Pulleys

Loosen the carrier cables and move them to the side of the pulley. Rotate pulley and check for binding, inspect surface of pulley for evidence of cable sliding across pulley without the pulley rotating. This should be done routinely while the device is in operation, as a failing pulley may bind under heavy loads, but not under light loads. If a pulley is found to be defective replace with Part # xxxxxxxx from Grainger.

4.2.6 Cable Ends

This problem is normally apparent by a deviation from circularity in line with the failing cable.

Step 1: Visually inspect the entire length of each cable for twisting and fraying. Pay special attention to the cable ends that attach to the bottom plate.

Step 2: Remove carrier and cable setup from the device.

Step 3: Perform a uniaxial tension test from 30N – 1000N. Make sure that the carrier is properly supported in a manner that it does not contact the cable while the test is performed.

Step 4: If the cable fails in the tension test, replace the cable as explained in section X.X.

Step 5: If the cable does not fail, remove another carrier and cable setup from the device and perform a uniaxial tension test. If the stress-strain relationship is different than the first test replace the underperforming cable as explained in section X.X. (Note that the material properties of the cables may change with repeated use, so when replacing any cable all other cables should be checked to insure that they have as close of a stress-strain relationship as possible, any deviation greater than XX will invalidate the testing.)

4.2.7 Bushings

Step 1: With no sample attached and cable slacked manually translate the carrier along the linear rods to check for binding.

Step 2: Remove suspect carrier from linear rods (see section X.X).

Step 3: Visually inspect the bushings for signs of excessive wear. Clean inside surface of bushings with a rag and XXXXX cleaner. Replace worn bushings.

Step 4: Visually inspect linear rods for straightness by rolling the rod across a flat surface. Clean rods with a cloth and XXXXX cleaner. Replace rods that are not straight with part # xxxxx from McMaster-Carr.

Step 5: If there are no signs of wear on the bushings, rods are straight and all parts are clean apply XXXXX lubricant and reinstall rods and carriers.

5.0 Maintenance

The device should be calibrated every time it is taken off an MTS machine and put back on. The hardened steel rods should be lubricated if chattering begins occurring in the carriers.

6.0 Major Future Repair

- Nuts and bolts should be replaced if the threading begins to strip.
- Cables should be replaced if strands begin to break because load limit will begin to decrease.
- Grips should be replaced or altered if slipping begins to occur in the sample.

7.0 Spare Parts Needed

There are several parts that will remove wasted time from the testing process if attained before a problem occurs. These include:

1. 1/16” wire cables – purchased from a local bike store
2. End-fitting inserts - purchased on www.mcmaster.com #XXXXX
3. End-fittings – purchased on www.mcmaster.com #XXXXX