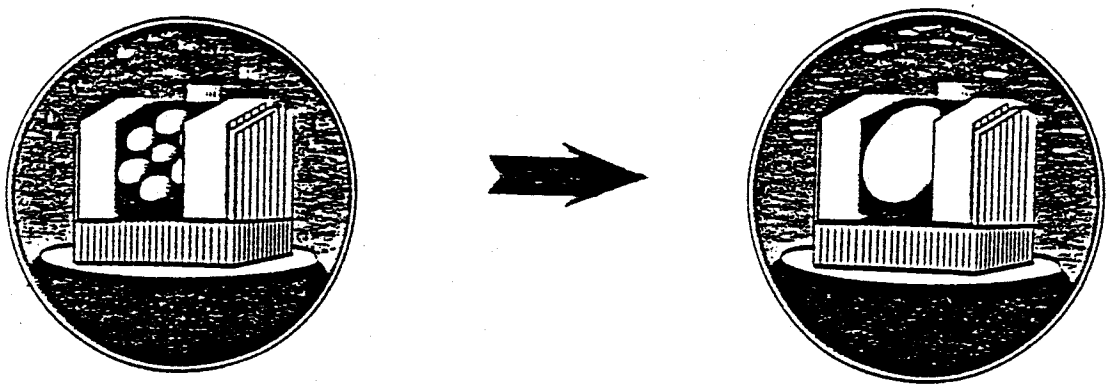
6.5 METER TELESCOPE



MMT Conversion Technical Memorandum #94-3

Destructive Stress Tests of the 6.5 m Loadspreader Flexures

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Multiple Mirror Telescope
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1.0 Abstract

This report examines two experimental tests of the loadspreader flexures. Both annealed and heat treated flexures were tested with applied shear forces and applied bending moments. This report concludes that heat treated flexures have the best material properties and margin of safety.

2.0 Introduction

All of the test flexures were fabricated from annealed 4340 high alloy steel from Jorgensen Steel. Half of the test flexures were then heat treated at the Steward Observatory Mirror lab to an average Rockwell C hardness of 47; the remaining half were tested as originally annealed from the manufacturer. All of the following tests were performed on both the annealed and the heat treated flexures.

3.0 Test results

The proportional limit of a material is defined as the point where the stress-strain, force-displacement, or moment-rotation curves begin to deviate from a straight line.

The yield point is usually defined as the point where the permanent strain is 0.002 -0.005. For this report, the yield point was determined using a permanent strain of 0.005.

All calculations of the stress and strain use a minimum cross section of the flexure equal to 6.1 mm.

3.1 Shear Test

The first test applied shear force to a flexure while recording the displacement (Figure 1.) The results from this test can be seen in Figure 2. The corresponding shear-strain curves can be seen in Figure 3.

TABLE 1.

Shear Test	Proportional Limit (N)	Yield Point (N)	Proportional Limit (MPa)	Yield Point (MPa)
Annealed	9,700	10,300	320	340
Heat treated	10,500	14,600	360	~500

3.2 Moment Test

The second test applied a moment to the shoulder screw and measured rotation of the flexure (Figure 4). The results of the moment versus puck rotation test can be seen in Figure 5. Figure 6 shows the derived normal stress at the minimum cross section of the flexure versus angular rotation.

TABLE 2.

Moment Test	Proportional Limit (N-mm)	Yield Point (N-mm)	Proportional Limit (MPa)	Yield Point (MPa)
Annealed	6,000	12,000	300	580
Heat Treated	14,000	40,000	600	~1800

4.0 Conclusions

The test results taken together with the following considerations show that heat treated flexures have acceptable material properties:

1. The nominal maximum *lateral* force applied by the loadspreader to each puck is 833N (reference 1). If the proportional limit is the maximum permissible shear force then the factor of safety is 11.6 for the annealed flexure and 12.6 for the heat treated flexure.

2. Finite Element Models of the 3-puck loadspreader show that the maximum principal stress for 1000 N *axial* loads is 57.3 MPa (reference 2). The nominal maximum axial load applied by the actuators is less than 1500N (reference 1). If the proportional limit is the maximum permissible normal stress then the factor of safety is 3.5 for the annealed flexure and 7.0 for the heat treated flexure.