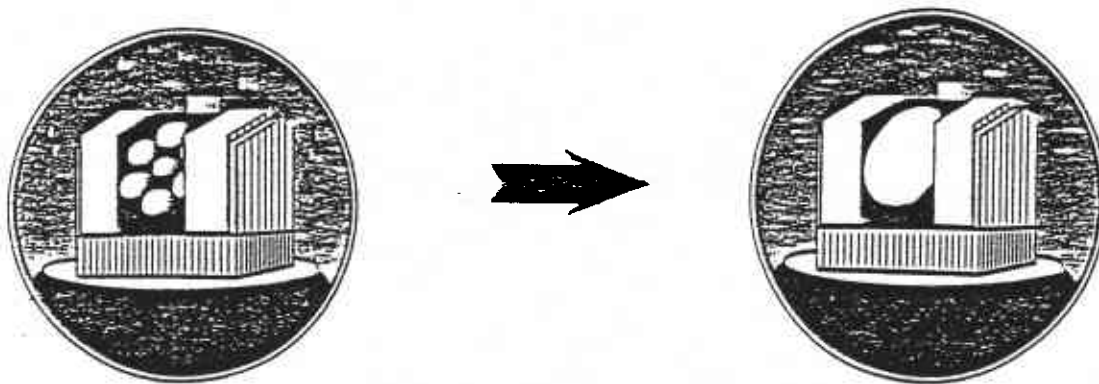


6.5 METER TELESCOPE



MMT Conversion Technical Memorandum #94-5

Analysis of the Hardpoint Attachment to the 6.5m Mirror

Shawn Callahan

April 1994

Analysis of the hardpoint attachment to the 6.5m mirror

Shawn Callahan, MMT Observatory

April 19, 1994

1.0 Abstract

This report describes the results of a finite element model of an E-6 wedge used to attach the six defining hardpoints to the mirror.

The model shows that a) the maximum stress in the wedge is well below the endurance limit of the glass used in the wedge; b) the axial stiffness of the hardpoint is not significantly reduced by the stiffness of the RTV bond layer or wedge; c) the stress concentration at the wedge-mirror interface is low.

2.0 Introduction

A wedge has been designed to provide a rigid coupling of the steel components of the hardpoints to the 6.5 m primary mirror (Figures 1 and 2). The hardpoints are bonded to this wedge with a 100 mm diameter layer of RTV, 0.5mm thick.

A finite element model of the wedge, glue, and steel components has been made to determine the maximum stress, axial stiffness, and pressure concentrations of the current wedge design (Figure 3).

3.0 Model Parameters.

The apparent modulus of elasticity of RTV has been measured at Steward Observatory for a 100 mm diameter glue layer 1.5mm thick. An FEA model was then created to simulate the test set-up used in the measurement. The modulus of elasticity used in the model for the glue was adjusted to give the model glue joint the same stiffness as the measured stiffness. The final value of the RTV modulus of elasticity, 0.93MPa, was then used in the models of the wedge.

The thin layer of optical cement that bonds the wedge to the mirror is not included in the model. The wedge is assumed to be rigidly constrained at the wedge-mirror interface.

The wedge in this model is perforated by six holes to reduce the thermal mass.

4.0 Model results

4.1 Maximum Stress in E-6

When 3000N loads, the maximum anticipated, are applied to the wedge with a 100 mm diameter puck, the maximum principal stress in the wedge is 0.34 MPa (50 psi), well below the 0.7 (100 psi) maximum stress specification for the E-6 glass (Figure 4).

4.2 Axial Stiffness

The model predicts that the axial stiffness of the wedge and 0.5 mm thick glue joint is 1360 kN/mm.

4.3 Stress concentration at the mirror-wedge interface

The maximum stress at the mirror interface is 0.34 MPa. This is equivalent to the maximum stress applied to the mirror by a loadspreader puck with a pressure concentration factor equal to 3.

The average pressure applied over the base of the wedge is 0.30 MPa. The ratio of the maximum pressure to the average pressure is 1.32.

5.0 Summary

If the maximum axial force applied to the hardpoint is 3000 N then the maximum stress in the glass wedge is safely within the 0.7 MPa (100 psi) endurance limit determined by Steward Observatory Mirror Lab. The axial stiffness is high enough to not significantly degrade the performance of the hardpoints. The stress applied to the mirror is safe and well distributed across the bottom of the wedge.

6.0 List of Figures

Figure 1. Wedge layout on the mirror.

Figure 2. Detail views of wedge.

Figure 3. Finite Element model of the wedge.

Figure 4. Principal stress in the wedge.

7.0 References

- 1) Gray, P.M., "Experimental Investigation of Silicone Adhesives for Mirror Support". Report #1. Steward Observatory 10/14/93.

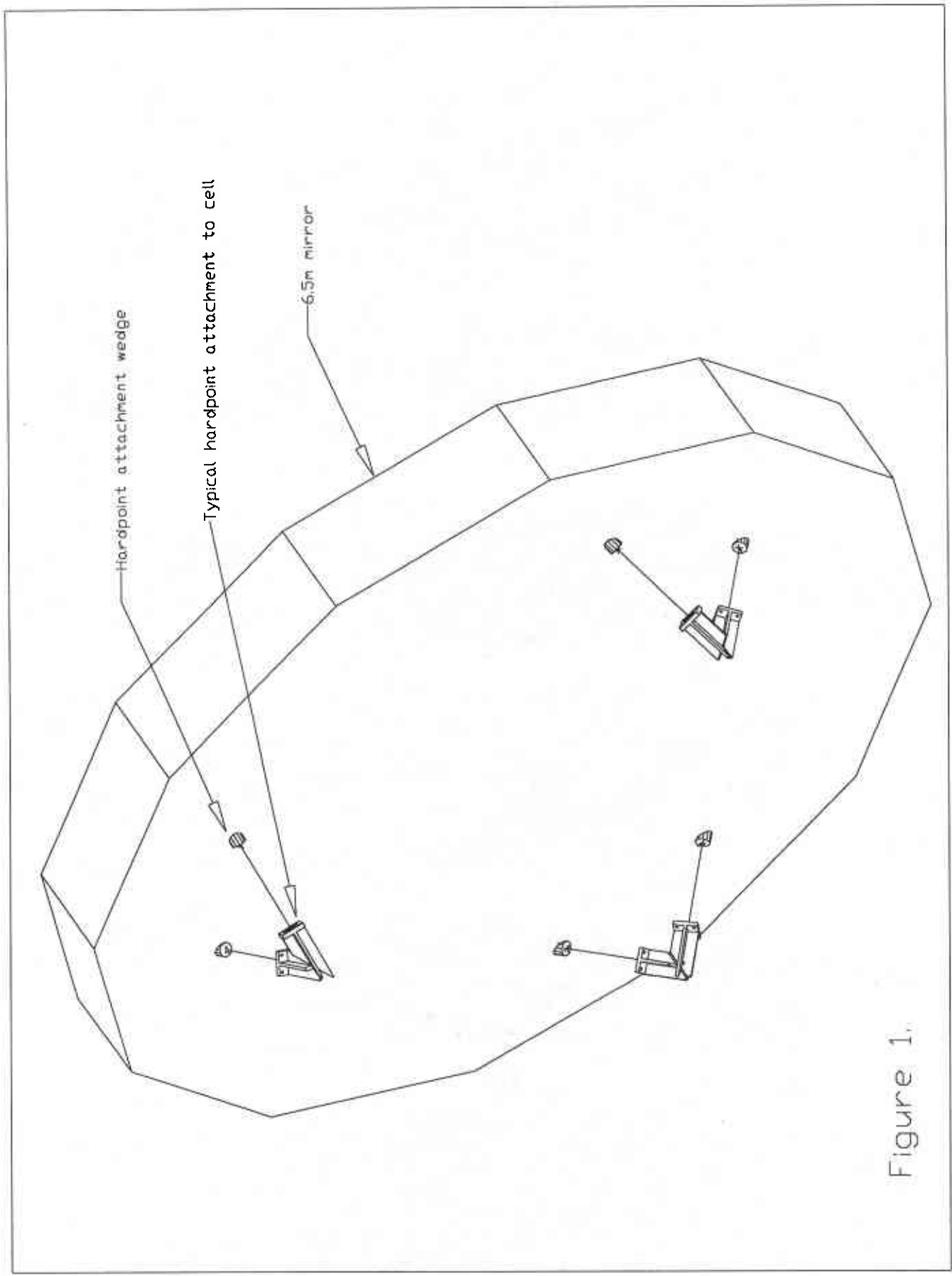
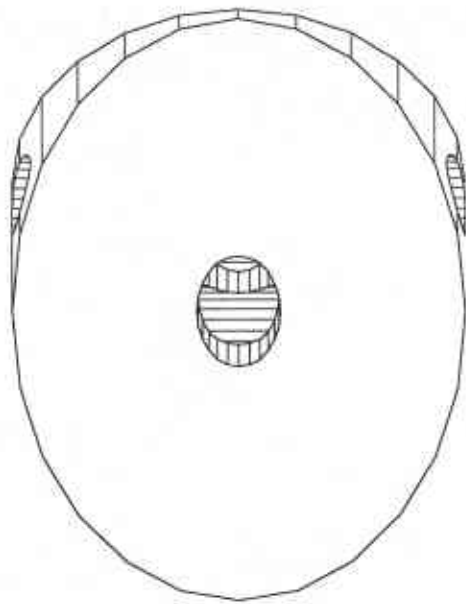
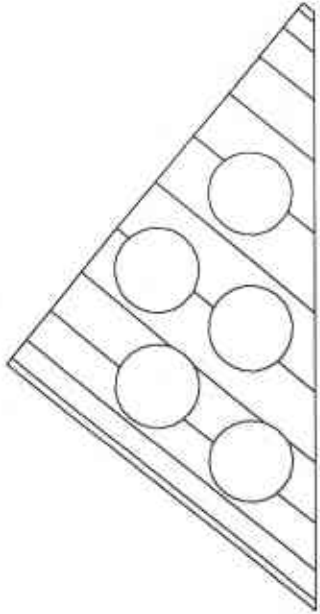
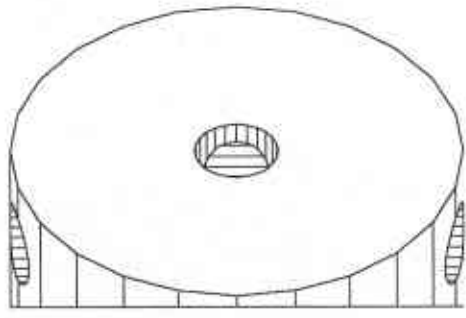
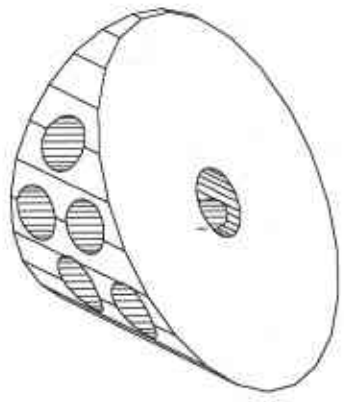


Figure 1.

REVISIONS		DATE	APPROVED
LTR	DESCRIPTION		



QTY		PART OR DWG NO.		DESCRIPTION		ITEM NO.	
				LIST OF MATERIALS			
UNLESS OTHERWISE SPEC.		DRAWN BY		UNIVERSITY OF ARIZONA & SMITHSONIAN INSTITUTION			
TOLERANCES UN		CALCULATED BY		MULTIPLE MIRROR TELESCOPE OBSERVATORY			
DECIMALS		CHECKED BY		Tucson, Arizona 85721			
FRACTIONS		APPROVED BY		TITLE			
ANGLES		APPROVED BY		Hardpoint Wedge			
± 0.01		APPROVED BY		SCALE:			
± 0.001		APPROVED BY		1" = 4"			
± 0.0001		APPROVED BY		SIZE			
± 0.00001		APPROVED BY		C			
± 0.000001		APPROVED BY		DRAWING NO.			
± 0.0000001		APPROVED BY		#MMT0050			
± 0.00000001		APPROVED BY		Dwg File: mmT0050			
± 0.000000001		APPROVED BY		SHEET NO.			
± 0.0000000001		APPROVED BY		1			

Figure 2.

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Figure 4, Principal Stress