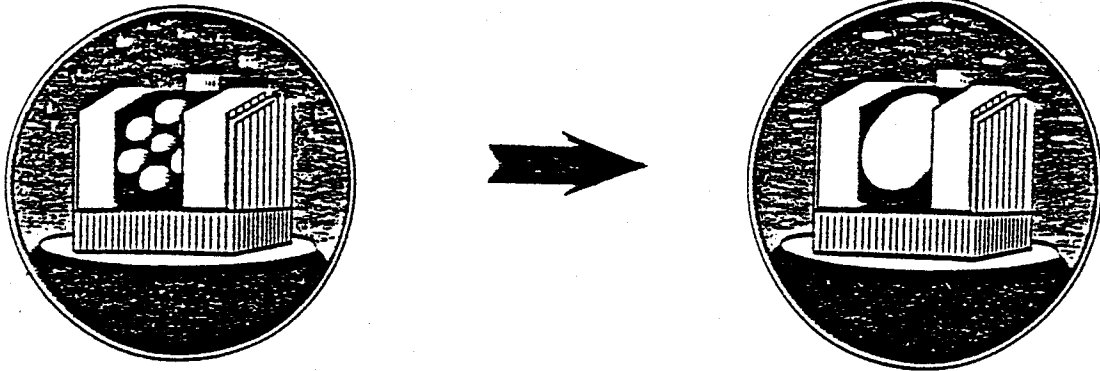


6.5 METER TELESCOPE



MMT Conversion Technical Memorandum #94-1

Contact Stress on the 6.5 m Mirror Due to Thermal Expansion

Shawn Callahan

January 1994

Contact stress on the 6.5 m mirror due to thermal expansion

Shawn Callahan, MMT0
January 28, 1994

1.0 Abstract

Three finite element models were created to determine the contact stress on the 6.5 m mirror due to thermal expansion of the support system attachment pucks and their flexures. The models show that the coefficient of thermal expansion (CTE) of the puck should be closely matched to the CTE of the flexural attachment to the load spreading frame.

2.0 Introduction

The 6.5 m mirror support system is attached to the mirror by metal disks (pucks) adhered to the backplate of the mirror with RTV. These pucks are bolted to high-strength steel flexures (Figure 1). Previous finite element models showed that the flexure needs to be made out of high-strength steel (reference 5). All of the models in this report use G43400CD alloy steel for the flexures.

The materials used in the pucks in these models are Invar 36, G43400CD, and a material with a CTE 10% greater than that of G43400CD. In each model the temperature is varied over a range of 40 C, and a 333.3 N axial force is applied to the center of each flexure (Figure 2). The resulting contact stress profile and the pressure concentration factor (PCF) is described in section 4.0.

All models assume a rigid mirror and uniform temperatures.

3.0 Model parameters

Axisymmetric plane elements with the material properties given in Table 1 were used to model the puck and flexure.

TABLE 1. Material Properties

Material	CTE (micron/m/C)	Young's Modulus -E (MPa)	Poisson Ratio	Yield Strength (MPa)
G43400CD alloy steel	11.0	200,000	0.29	682
RTV	324	5.6	0.49932	
Invar 36	-1.2	148,000	0.30	
E6 glass	2.9	65,000	0.24	

4.0 Model results

Figure 3 shows the stress applied normal to the mirror backplate (contact stress) across the radius of the puck for all three materials. Figure 4 shows an expanded scale plot of the contact stress profile for a steel puck.

Table 2 shows how the CTE of the puck affects the pressure concentration factor (PCF). To keep the stress in the glass below 0.7MPa, the PCF should be less than 3.0 (see reference 1). The lowest PCF occurs when the flexure and the puck have the same CTE.

TABLE 2. PCF versus Puck CTE

Material Puck	CTE (micron/m/C)	PCF axial load, delta T = 40 C
Invar 36	1.2	21.5
4340 Steel	11.0	3.1
Steel (CTE + 10%)	12.1	5.3

Figure 5 shows a magnified view of the displacement of the puck and flexure with a 40 C increase in temperature and a 333 N axial load applied to the top of the flexure.