Optimization of a 20:1 Aspect Ratio Mirror Blank Support

Independent Project Requirement Reviews OPTI 523

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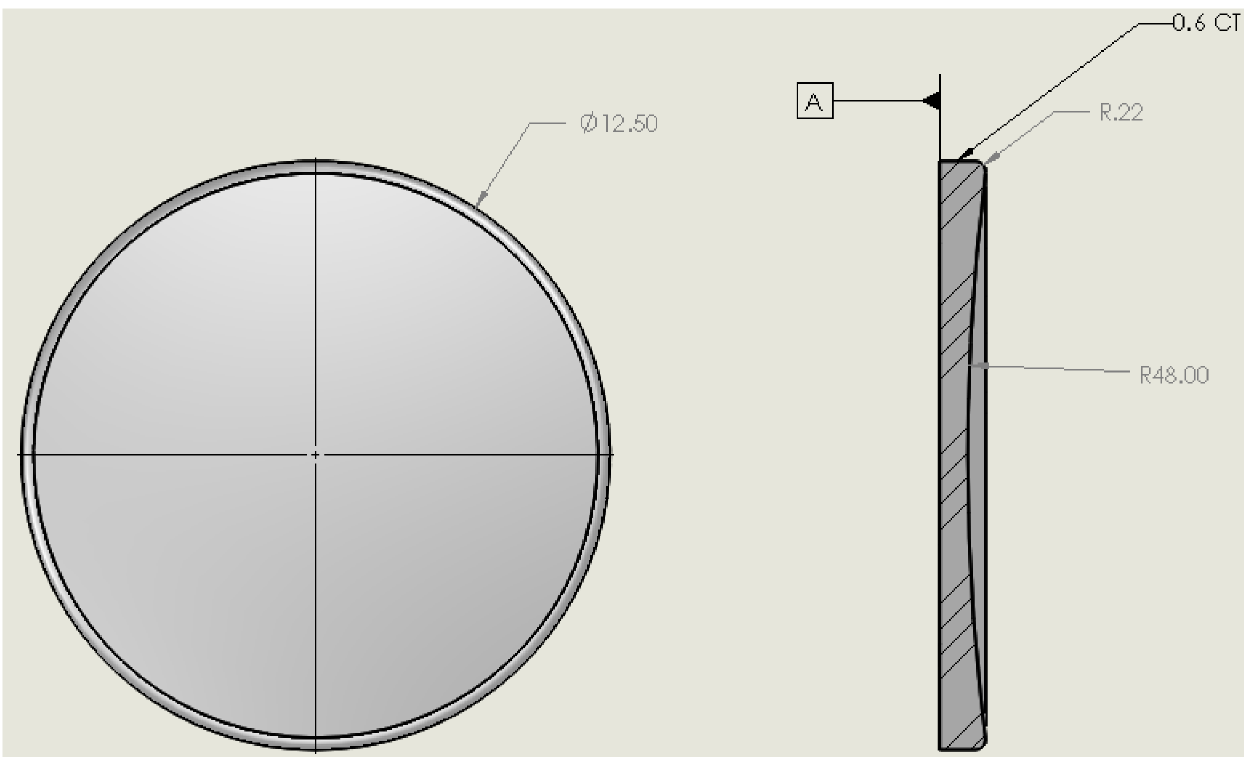
Scope

For this problem I want to optimize a mirror support for a relatively thin mirror blank with an aspect ratio of about 20:1. I believe the project will incorporate the same mirror blank dimension as in problem 5 but the thickness will be reduced by half (~.6”).

Develop a mount concept for a variable orientation mirror:

12” diameter,
.6” center thickness
Spherical surface: Concave radius of curvature of 48”
Material: ULE^{TM}



The scope of this project is to determine best possible support location that limits RMS surface error at various orientations (Zenith or Horizontal). I want to design a complete support system that has an interface to some plane. The project does not include motion control of the mirrors positional orientation.

Requirements

Top Level

- The project requirement will be the same as the project requirements set for problem five, which include the following:

This must achieve < 20 nm rms surface for zenith or horizon pointing, including

- Surface irregularity from specification
- Nominal self weight deflection
- Mount induced deflections (from flexures, tolerances,…)

This implies that the total of all three of these factors must be less that 20nm rms.

Operational

- The surface budget above is taken AFTER removal of power.
- Power tolerance comes from ROC = 48" +/- 0.5"

- Lowest resonant frequency > 80 Hz.

- Operational environment:
  20C +/- 10C

Operational position stability requirement:

- 200 urad tip/tilt
- 0.008" decenter
- 0.020" axial position

This stability requirement was doubled for the requirement set in problem 5. This is because this model is probably much more sensitive to loading from flexures. In order to mitigate this the flexures are to be made less stiff. This in turn will result in higher self weight deflection when orientated horizontally.

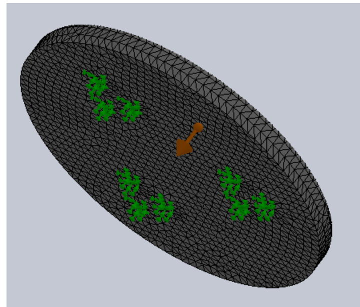
Survival:

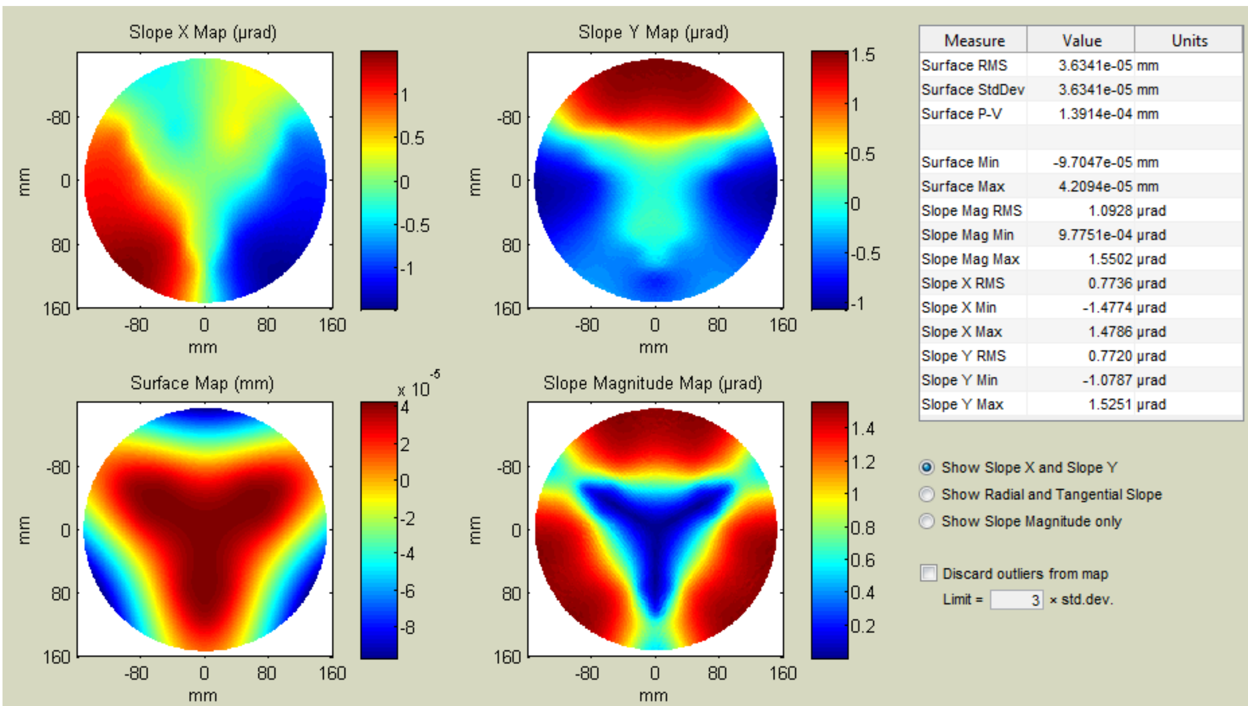
- -10C to 50C
- 20 G shock

The main concern for these two parameters would be the flexures. The flexures would have to be able to be compliant enough so that the temperature variations would allow compliant motion and loading form shock would not yield the material. The mirror so far way about 8 lbs, if there is nine point contact each point will carry a .9lb load. This implies a shock loading of about 18lbs (80N) per support…….

Design Preferences

For this design simplicity is essential to be able to evaluate the system in a Finite Element Analysis. This implies the results of the analysis should determine minimum number of points needed to support the mirror that limits self weight deflection. Ideally the support would be anywhere from a six point to nine point kinematic support. Here is a quick evaluation of what is to be expected as far as performance from self weight deflection. This mounting position where randomly chosen.





Some of the most important decisions I believe are the flexures stiffness and geometry, the kinematic support configuration, and the number of contact points needed to interface on the blank. The method of determining this will be similar to what was done on the previous problem.

Schedule

Requirement Review	Prelimianry Design Review	Final Review	Final Report
25-Mar	10-Apr	24-Apr	1-May

1. <u>Requirements Review</u>

The system concept is summarized and the specific requirements are clearly specified and approved.

Include specific plans for your project.

2. Preliminary Design Review
The preliminary design is presented showing how requirements will be met. Any trades to be made or decisions to be made based on engineering analysis are identified. Identify any key risks.

3. Final Review
Presentation showing complete solution to the problem, demonstrating compliance to the requirements.

4. Final Report
Document the solution. Must include engineering drawings of custom parts or procurement specs for purchased parts.

Implication of the Study

Many companies, in particular aerospace, have the need to incorporate light weight optics. There is a high demand for creating light weight and precise optical components. This project will give me the skill set to tackle such problems. The main focus is determining a correct method of creating a kinematic support for light weight mirrors.

I believe that with the tools learned in class the optimization of type of mirror is definitely possible. I believe there will be a positive outcome and solution to this problem.