Fermilab

SSC Detector Solenoid Design Note #7

January 19,1988

Finite Element Examination of Calorimeter Support Concept

Introduction

The purpose of this work is to examine the feasibility of a support concept for the 5000 tons of calorimetry which will reside within the SSC detector solenoid. The ANSYS finite element program was used to estimate primary stresses in the structure. There was no attempt to produce detailed stresses or other information necessary for detailed design.

Calorimetry Support Concept

The fundamental concept for supporting the SSC detector central calorimetry is that of concentric cylindrical shells connected by truss panels. This geometry is shown in Fig. 1. The plate thickness for this work were assumed to be 2 inches for both shells and panels. The support cylinders will be suspended from cables placed at the ends and the middle, as shown in the figure. It has not been decided if the cylinders will be continuous over their 16 m length or if a break will occur at 8 m, resulting in two distinct structures. For this analysis it was assumed that such a break exists.

The advantages of this geometry are high stiffness, relative ease of manufacture due to simplicity, and ability to include physics instrumentation in the annular space between the shells in an efficient way.

Finite Element Model

The finite element model of this support structure is shown in Fig. 2. The model assumes a symmetry point at 4 m axially, and at the midplane angularly. The calorimeter load is applied as a line load along the inner cylinder at theta=45 deg. This is a rational place for the loading, since it is directly over a truss panel. The load applied is 1/8 th of the total calorimeter weight of 5000 tons.

Results

The distorted shape of the support structure under load is shown in Fig. 3. The maximum vertical deflection is 0.72 in. The stress results show that the maximum stress intensity occurs near the support, and is 36000 psi. This is a local effect which can be readily eliminated by the detailed design of the support. Another area of high stress is encountered in the interior of the inner support cylinder at theta=60 deg. Values of stress range from 20000 to 28500 psi. (The stresses presented here are stress intensities) The AISC allowable for stress in this region would be $0.67S_y$, or 0.67(30000) = 20100 psi for 304 stainless steel. Because this stress has a large bending component it will respond rapidly to thickening of the inner cylinder either globally or locally.

Conclusion

This work shows that the concentric cylinder support concept is viable. The area around the support is highly stressed as expected, but will be amenable to local solutions in the detailed design. The inner cylinder sees appreciable stress on its inner surface, but local thickening would decrease this stress, and a closer examination might lead to more elegant solutions.

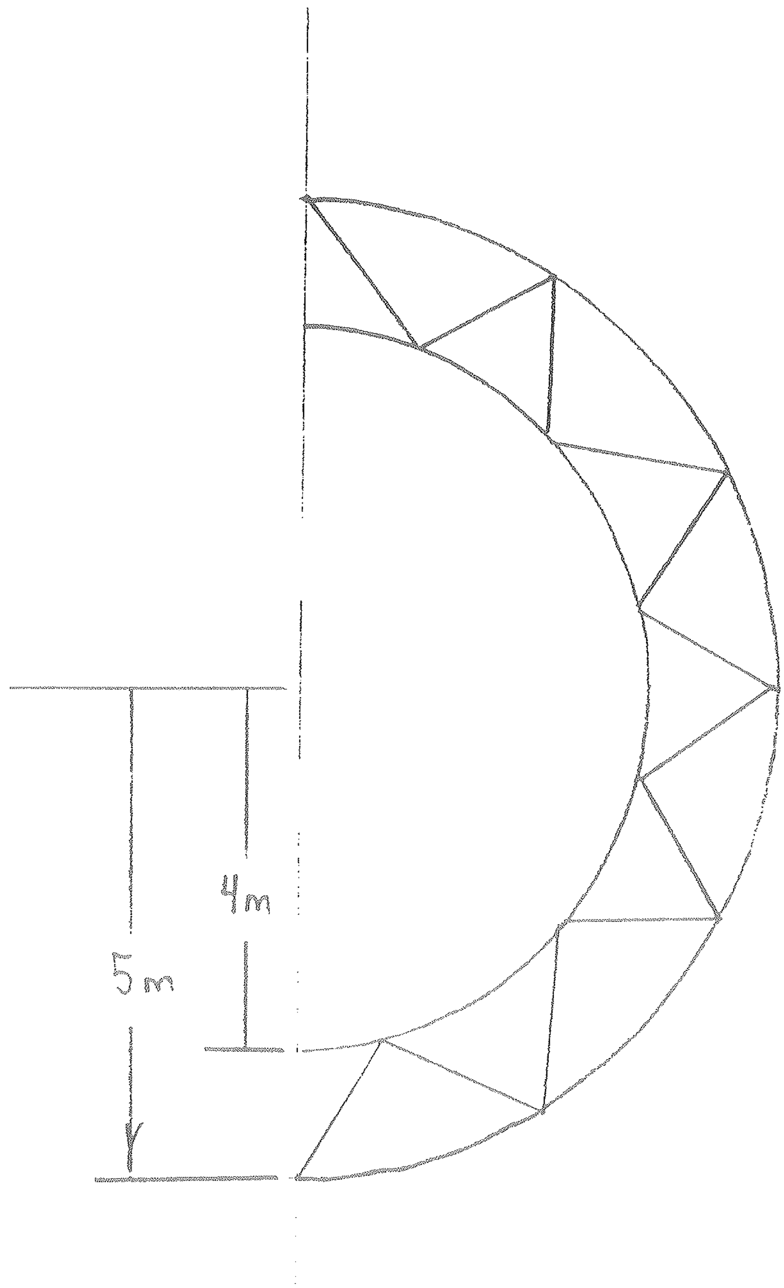
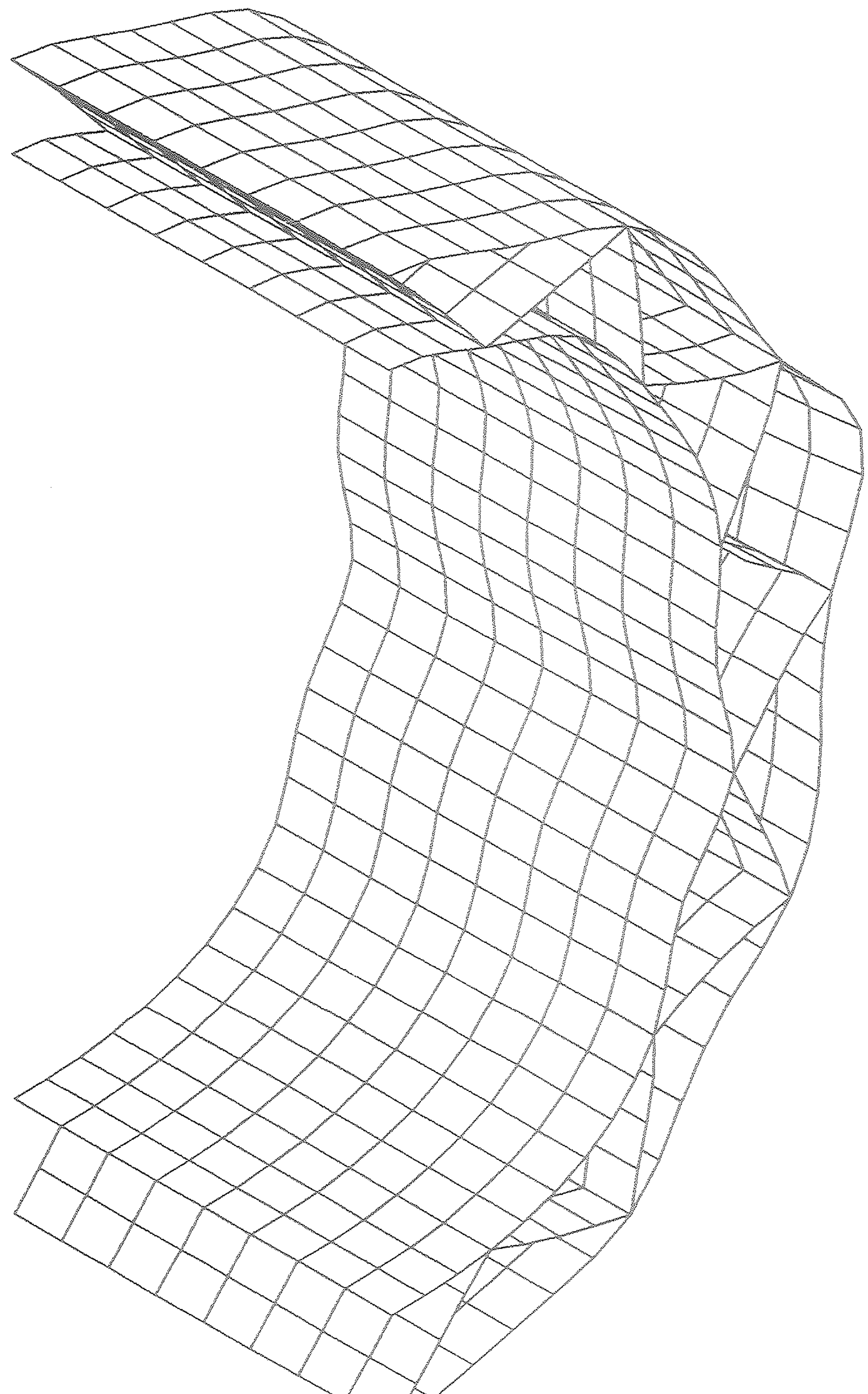


Fig 1. End View of Calorimeter Support

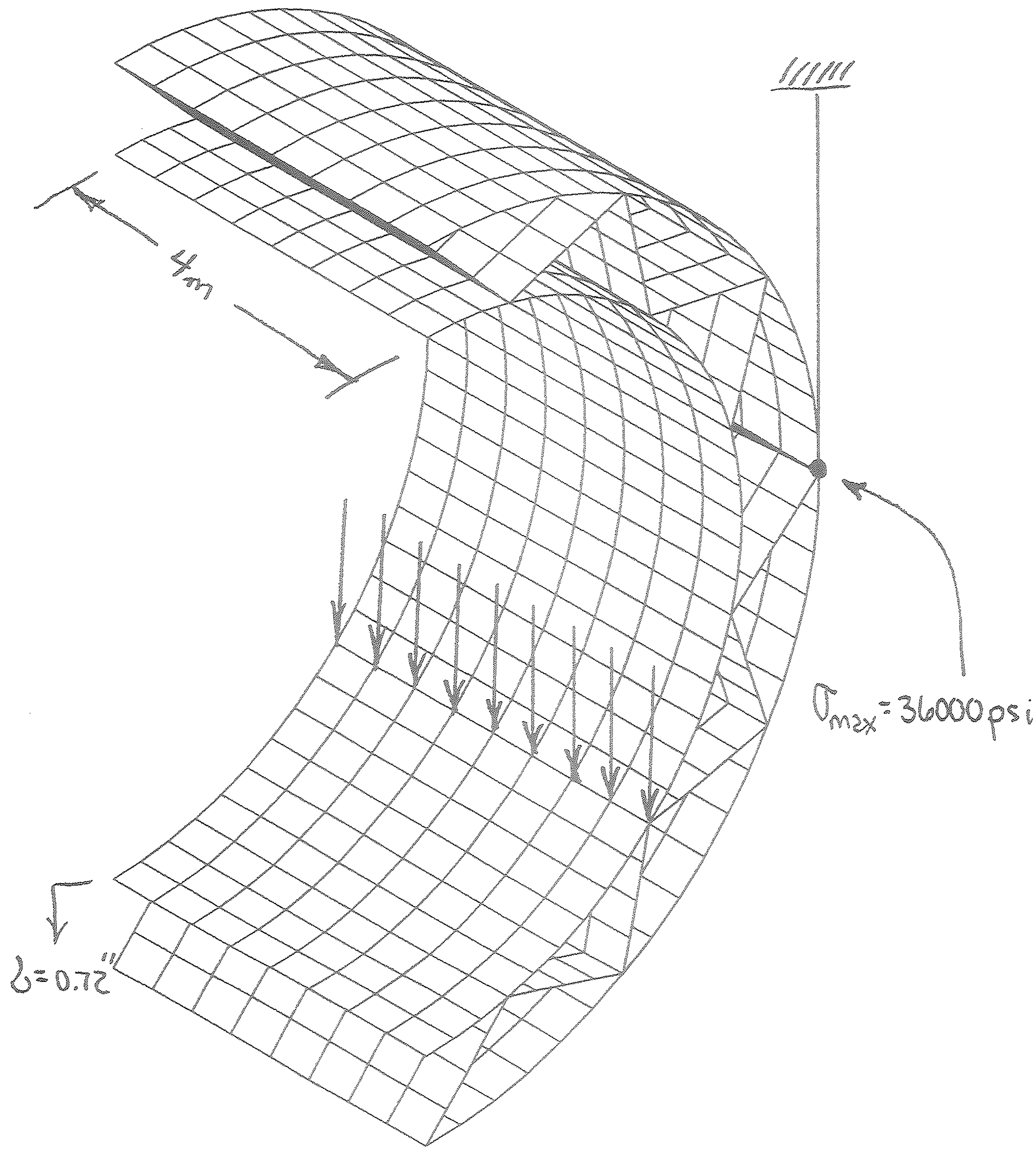


1 CALORIMETER SUPPORT 8M ID, 10M OD

ANSYS 4.3
JAN 19 1988
11:19:15
PLOT NO. 2
POST1 DISPL.
STEP=1
ITER=1

ORIG
XV=-1
YV=1
ZV=1
DIST=223
XF=66.7
YF=-5.87
ZF=-47
HIDDEN
DMAX= 0.72
DSCA=3.43

Fig 3. Distorted Shape



1 CALORIMETER SUPPORT 8M ID, 10M OD

ANSYS 4.3
JAN 19 1988
11:17:29
PLOT NO. 1
POST1 ELEMENTS

ORIG
XV=-1
YV=1
ZV=1
DIST=223
XF=66.7
YF=-5.87
ZF=-47
HIDDEN

Fig 2. Finite Element Model