FE Analysis Example

Structural Integrity verification of loads on the deck on a structure

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1. Introduction

This report documents how the Lisa Finite Element program has been used to assess the structural integrity of a steel deck, which consists of beams and plates. It demonstrates how the LISA FE program can be used for such types of analyses, and the ease by which it is possible to combine 2-D beams elements and 8-node shell elements.

The report discusses the following:

Technical description of the structural scope of work
Description of the loads
Finite element model
Results
Conclusions

2. Technical Description

The support frame shown in Figure 2-1, placed on top of the deck structure (See Figure 4-1).

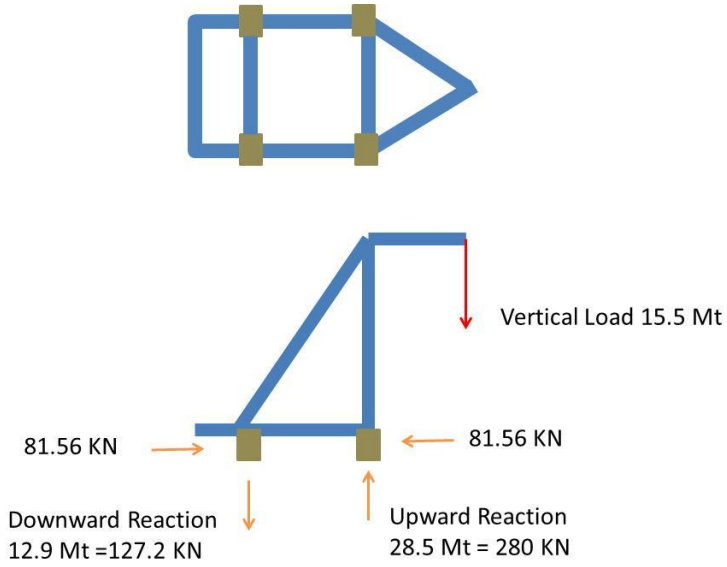


Figure 2-1 The frame supported on the Deck of the structure

A load of 15.5 Mt is suspended from the support frame. The reaction forces are shown in Figure 2-1. The reaction forces depend on the stiffness distribution of the frame. These reaction force values are pre-calculated and applied as forces on to the actual model that is developed in LISA.

3. Load Description

A brief description of applied loads and load factors is shown in Table 3.1.

Table 3-1Description of Loads on the deck

No.	Description	Magnitude
1.	Vertical Load applied on the frame Load Factor of 1.1 applied for weight in-accuracy Load Factor of 1.35 applied for dynamic factors	Vertical Load = 15.5 Mt Load Factor = 1.1 * 1.35 = 1.485 Factored Vertical Load = 23.02 Mt = $225.8*10^3$ N (Corresponding reaction forces are also multiplied by these load factors)
2.	Self-weight of structure (a load factor of 1.2 is applied on the acceleration due to gravity)	4.70 Mt = 46,094.3 N 46,094 N * Load Factor of 1.2 = 55513.20 N

4. Finite Element Model

The finite element model is generated using 2-D Frame elements for the beams and quad-8 shell isotropic elements for the plates. The FE model is shown in Figure 4-1. One of the advantages in LISA is that the loads need not be applied on the final FE mesh. LISA has the functionality for re calculating the loads after the mesh is refined. The loads can be graphically displayed in LISA.

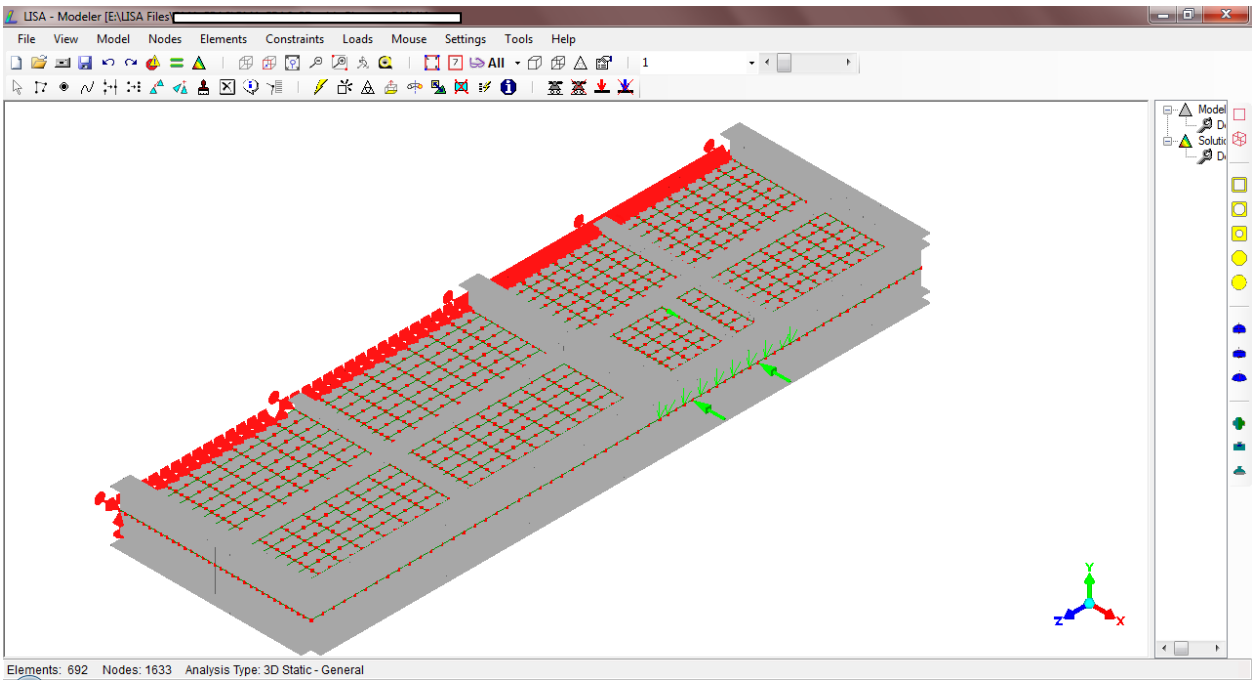


Figure 4-1 FE model of the structure analysed

5. Results

Plots showing important results are given in the Figure 5-1 to Figure 5-3. More plots are provided in Annex I.

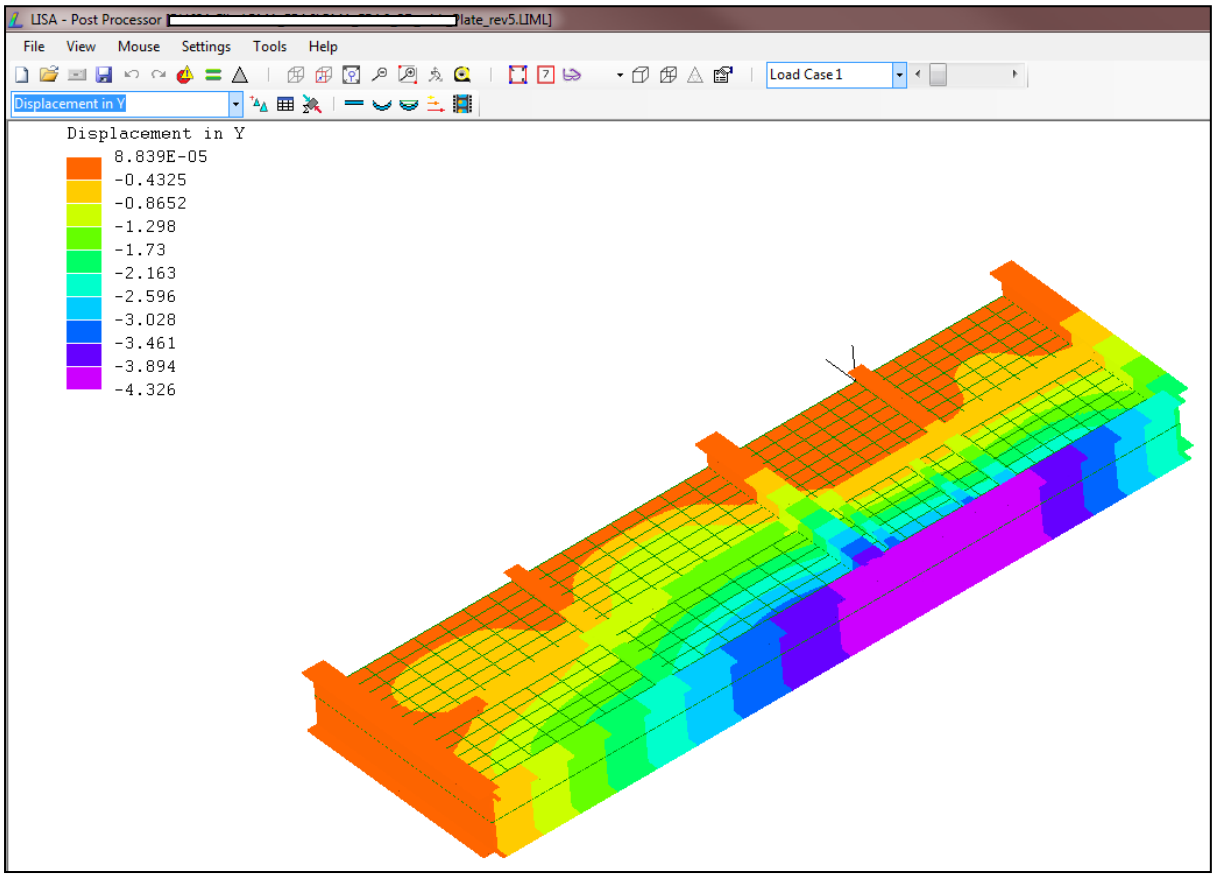


Figure 5-1 Plot of Vertical Displacement

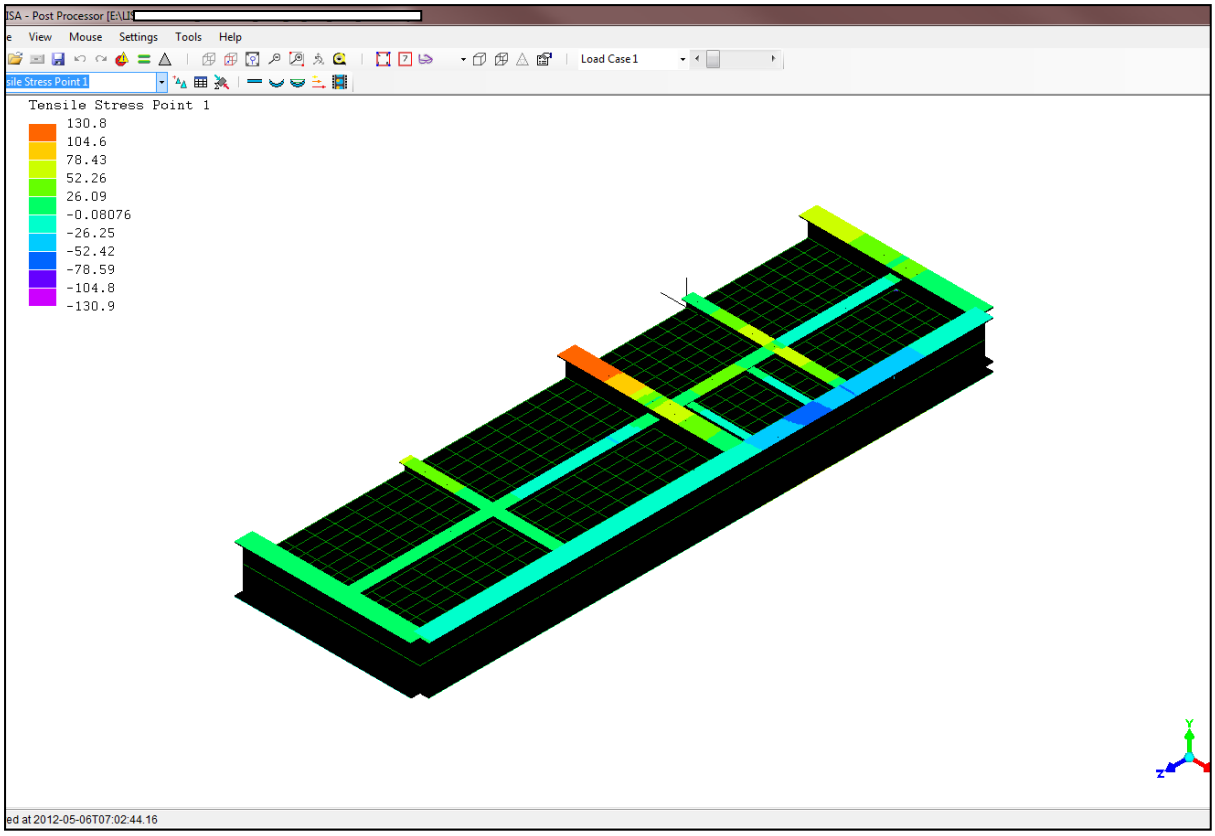


Figure 5-2 Plot showing Maximum stresses in the beams

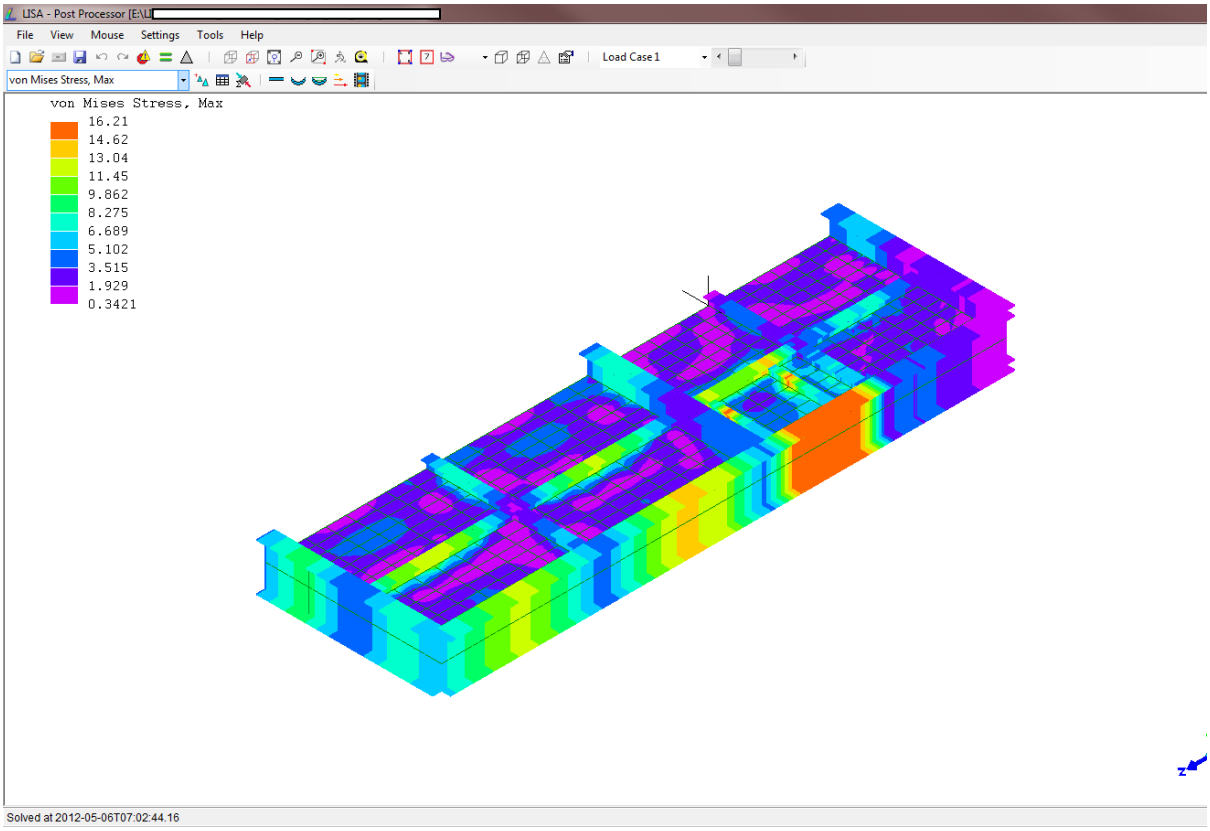


Figure 5-3 Plot showing Von-Misses stresses in the plat

The important results are summarised in Table 5-1

5-1 Summary of Important results

No.	Description	Magnitude
1	Maximum Displacement in the vertical direction	-4.3 mm
2	Maximum Compressive stress in the beam	130.8 MPa ~ U.C. = 0.56 assuming an allowable capacity of 0.67 F_y = 231 MPa (F_y = 345.0 MPa)
3	Maximum Von-misses stress in the plate	16.21 << 0.67 Fy

The results and plots indicate that the structural capacity of the deck is sufficient to withstand the loads due to the frame

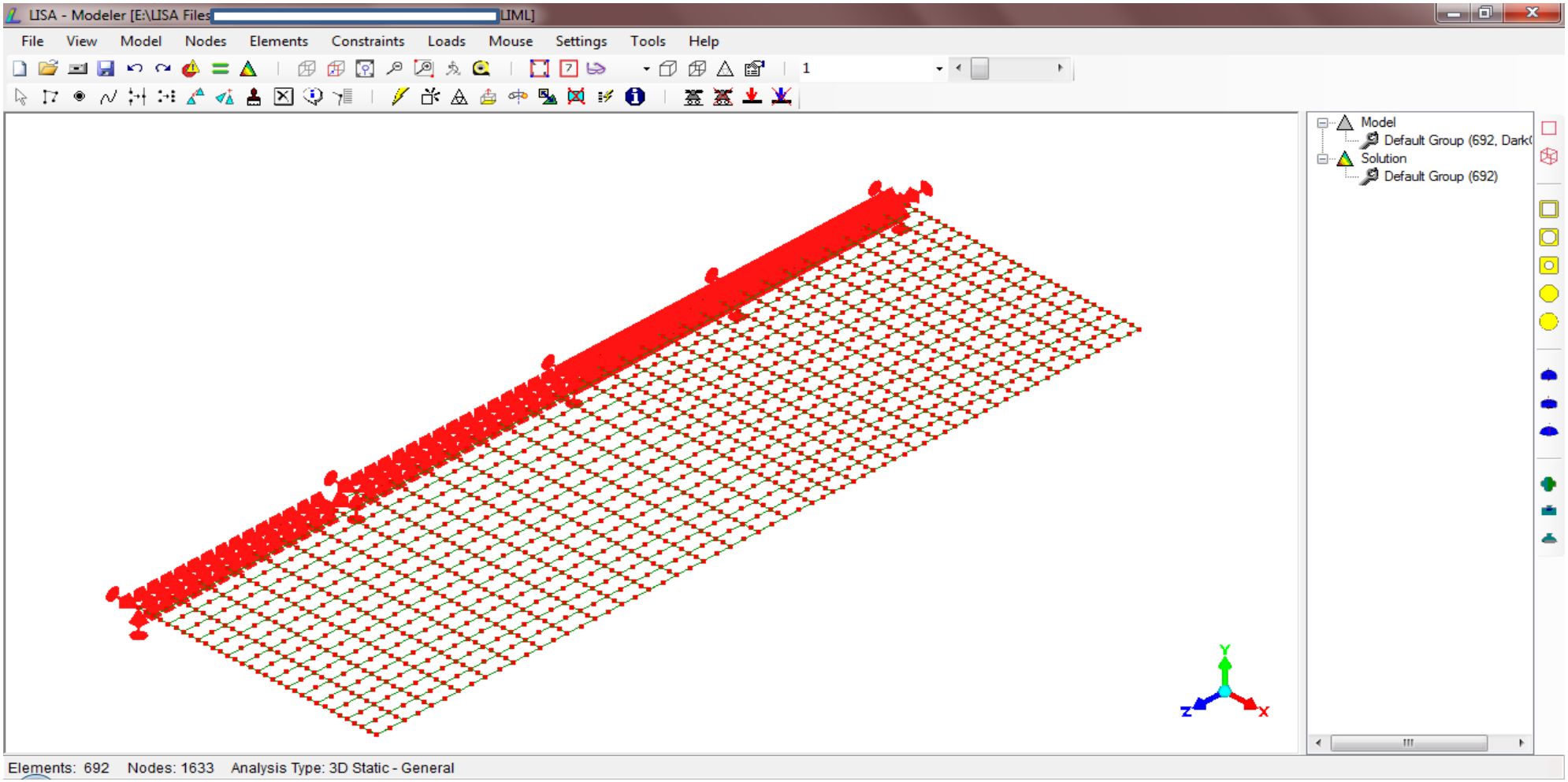
6. Conclusion

Based on the analysis presented above, the capacity of the deck to withstand the load of 15.5 Mt from the frame is adequate.

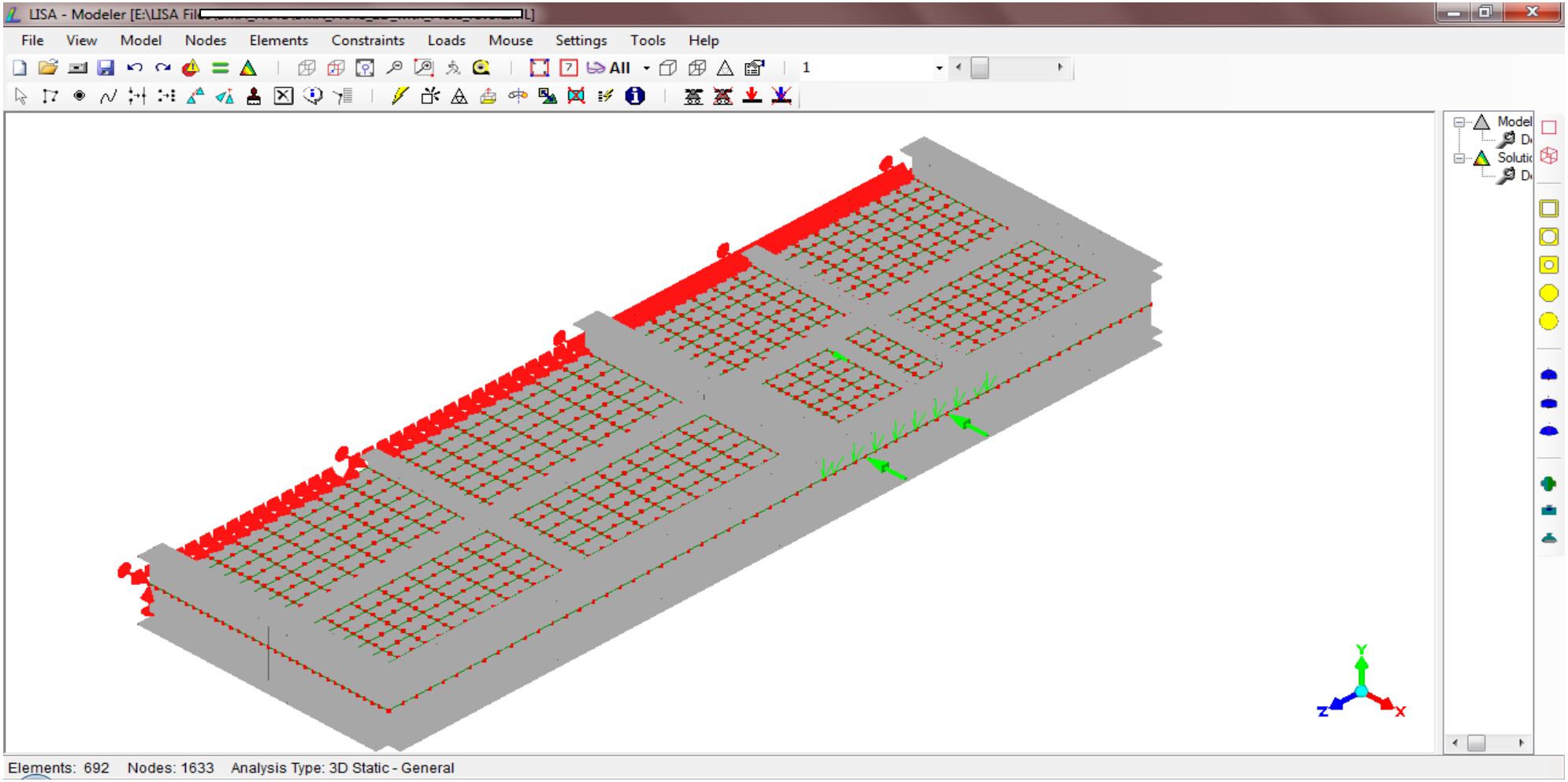
Annex I

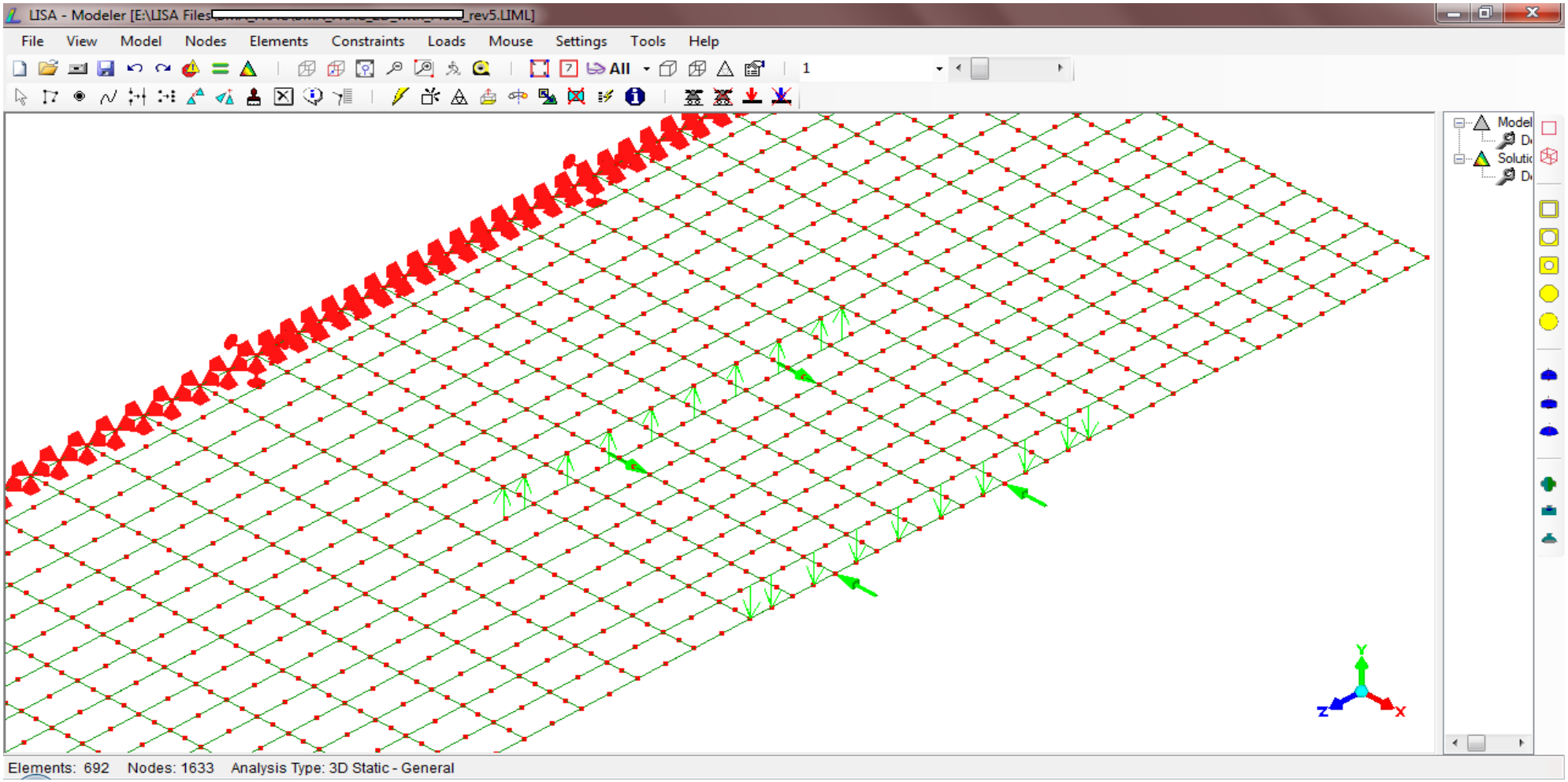
FE plots of the structure model and results

Finite Element Plot of the Structure Analyzed



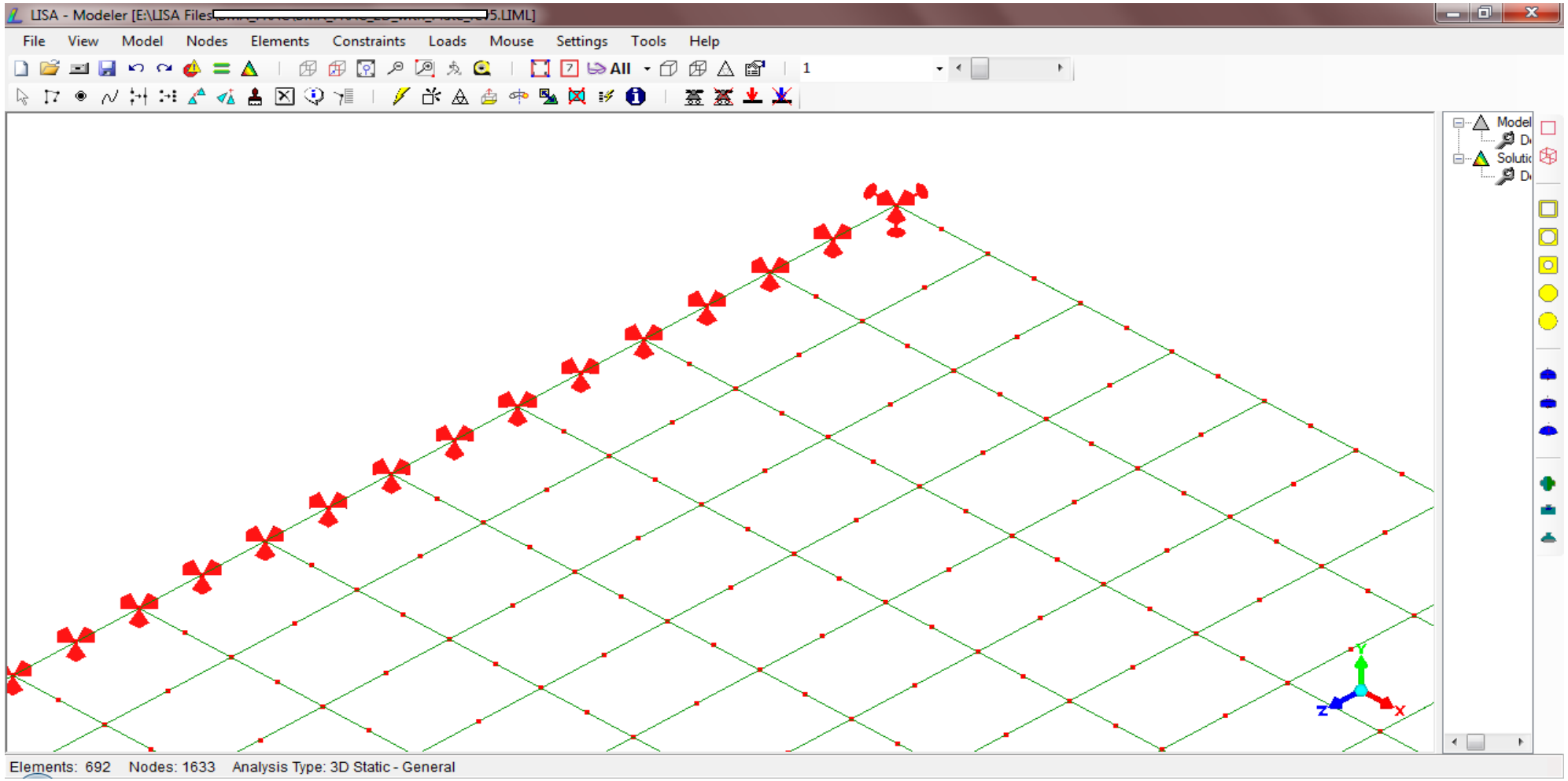
3-D model of Beams and Plates, showing loads from the Hanger Hose



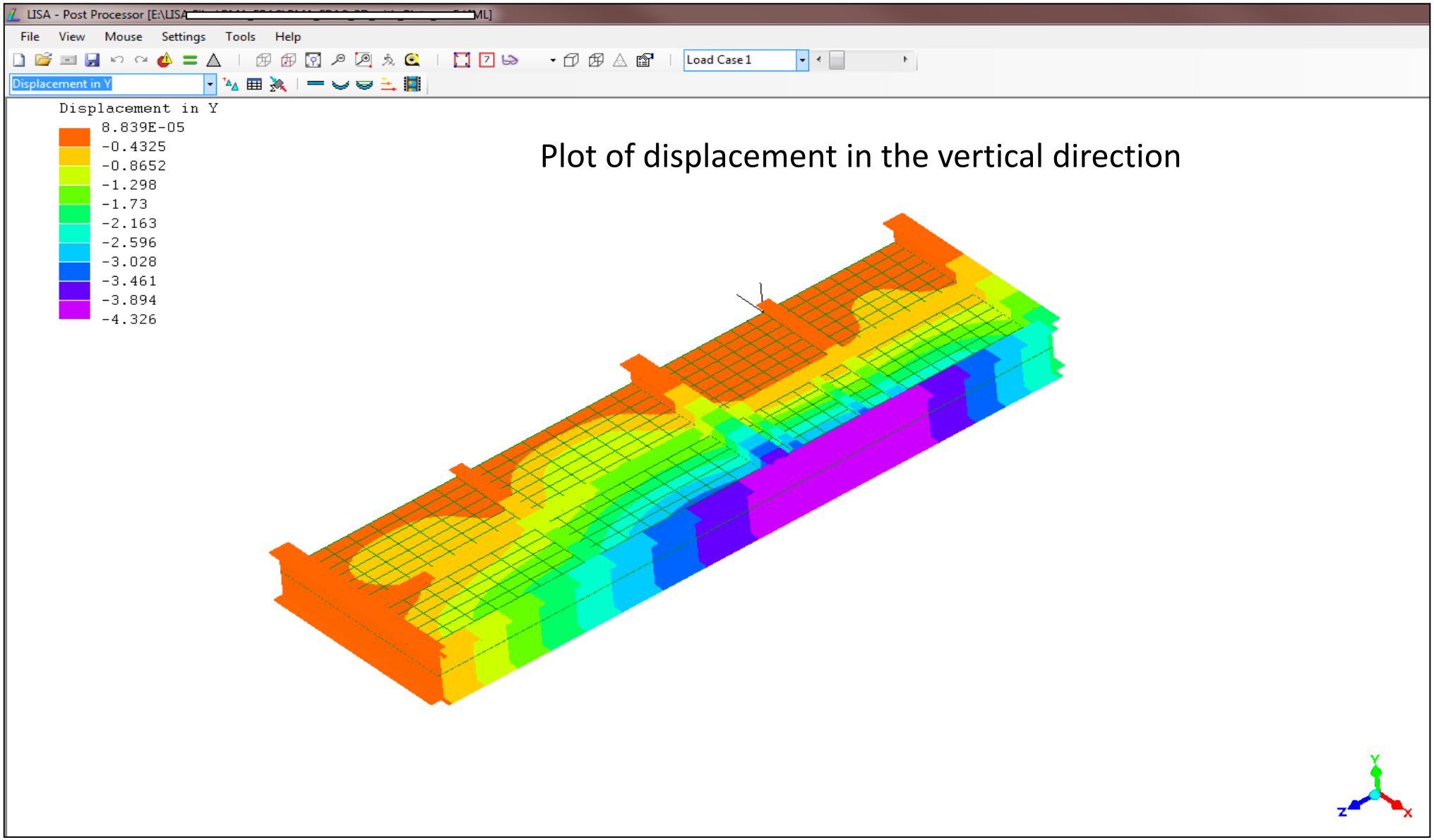


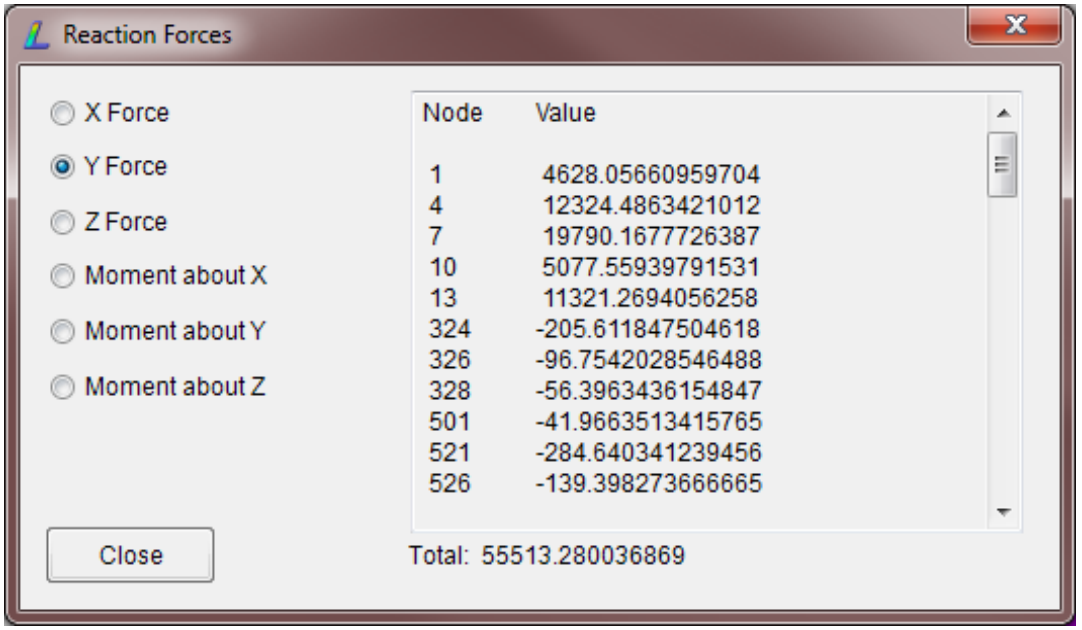
Location of Hose Hangers

Typical Boundary Conditions



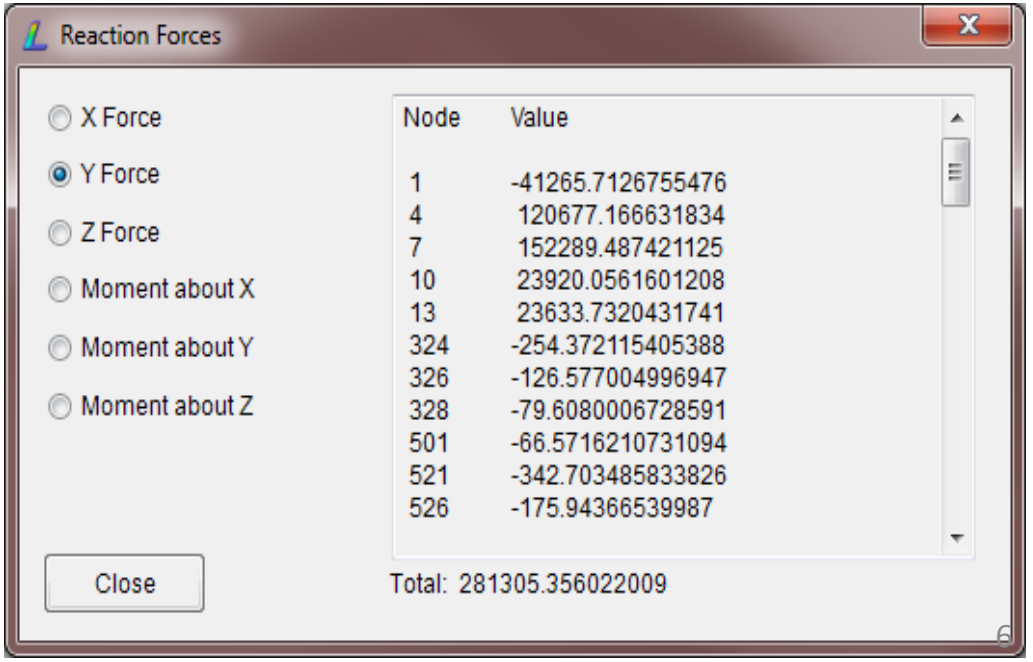
Plot of displacement in the vertical direction





Reaction Loads in Vertical Direction due to self weight of the structure X load factor of 1.20

Reaction Loads in Vertical Direction due to self weight and hose hanger loads



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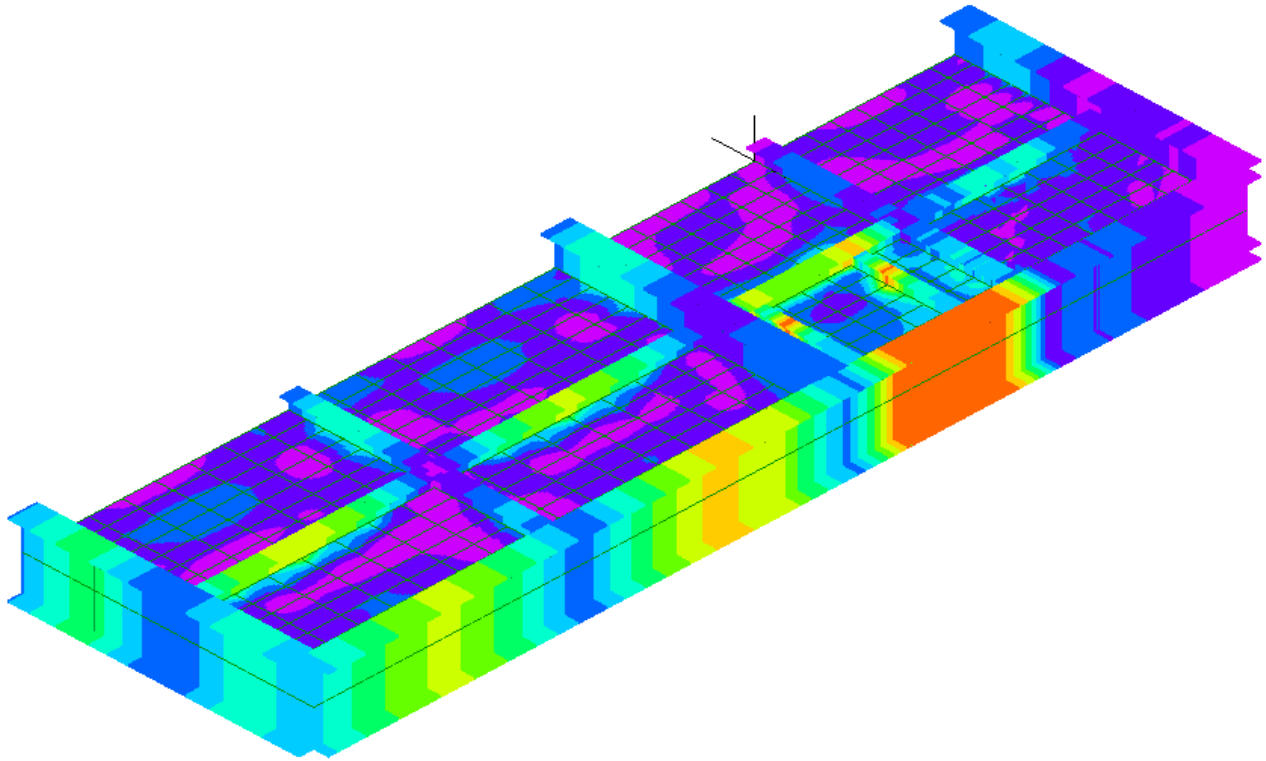
File View Mouse Settings Tools Help

Load Case 1

von Mises Stress, Max

von Mises Stress, Max
16.21
14.62
13.04
11.45
9.862
8.275
6.689
5.102
3.515
1.929
0.3421

Von-misses stresses on the plate



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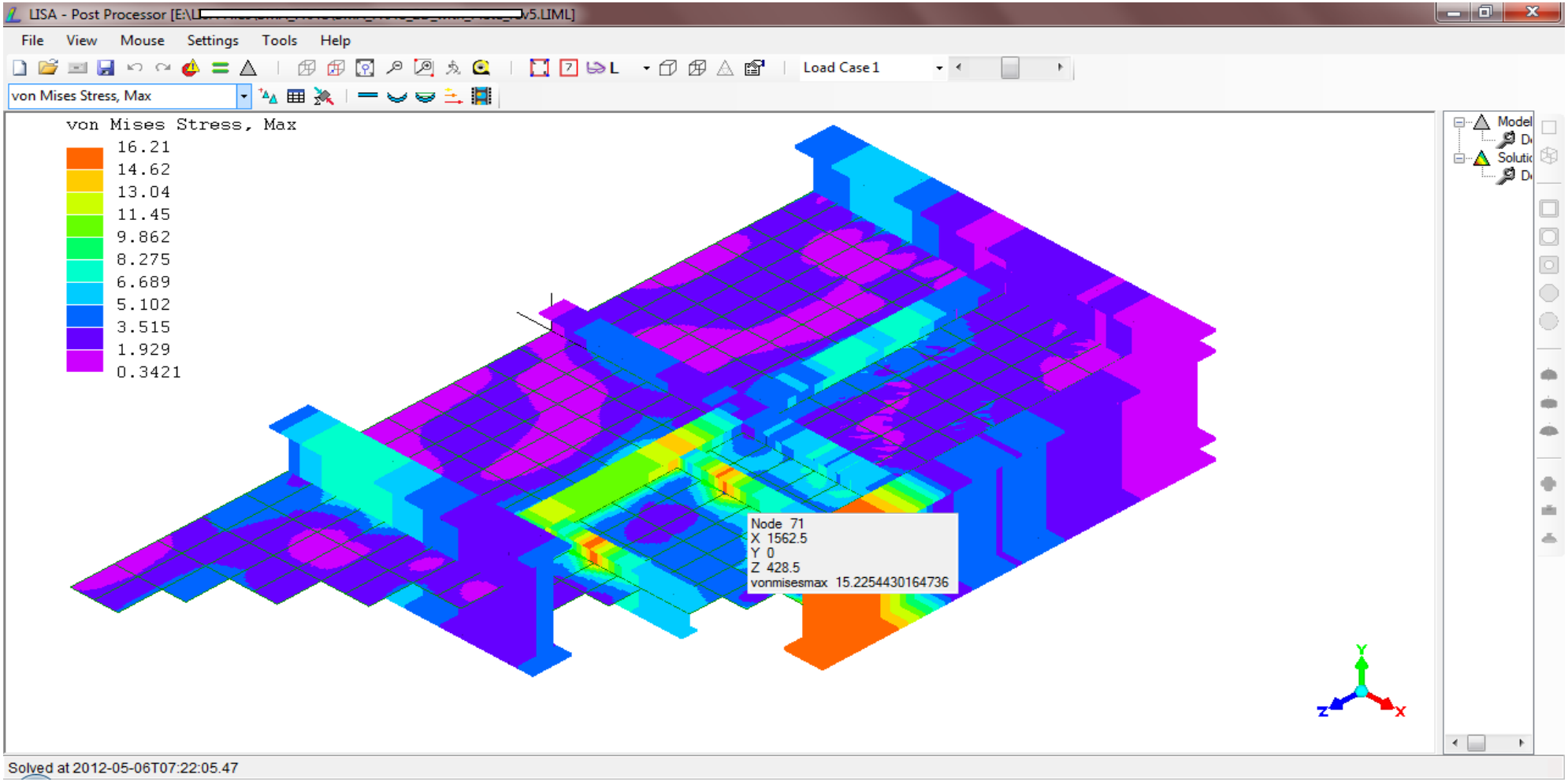
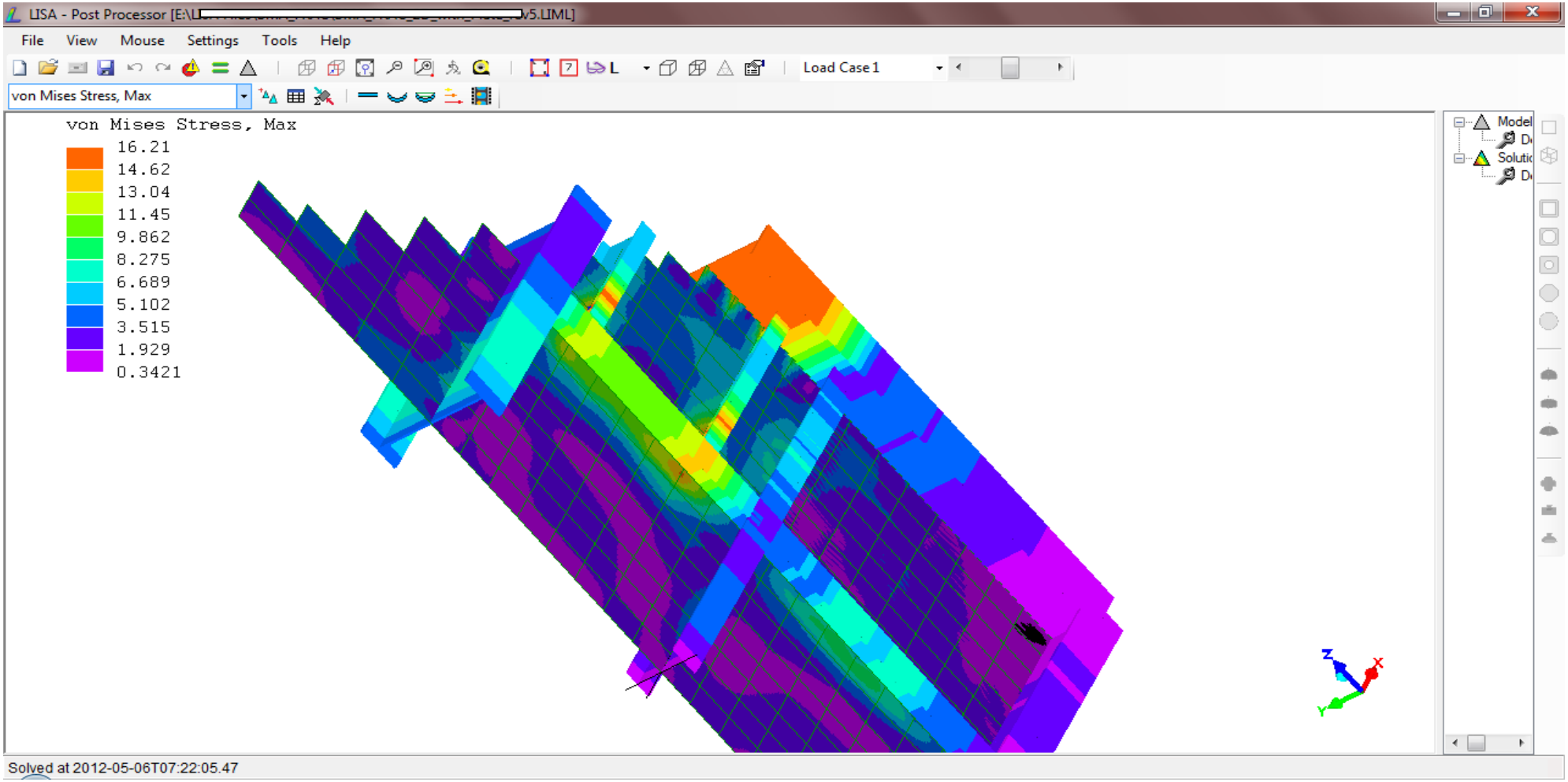
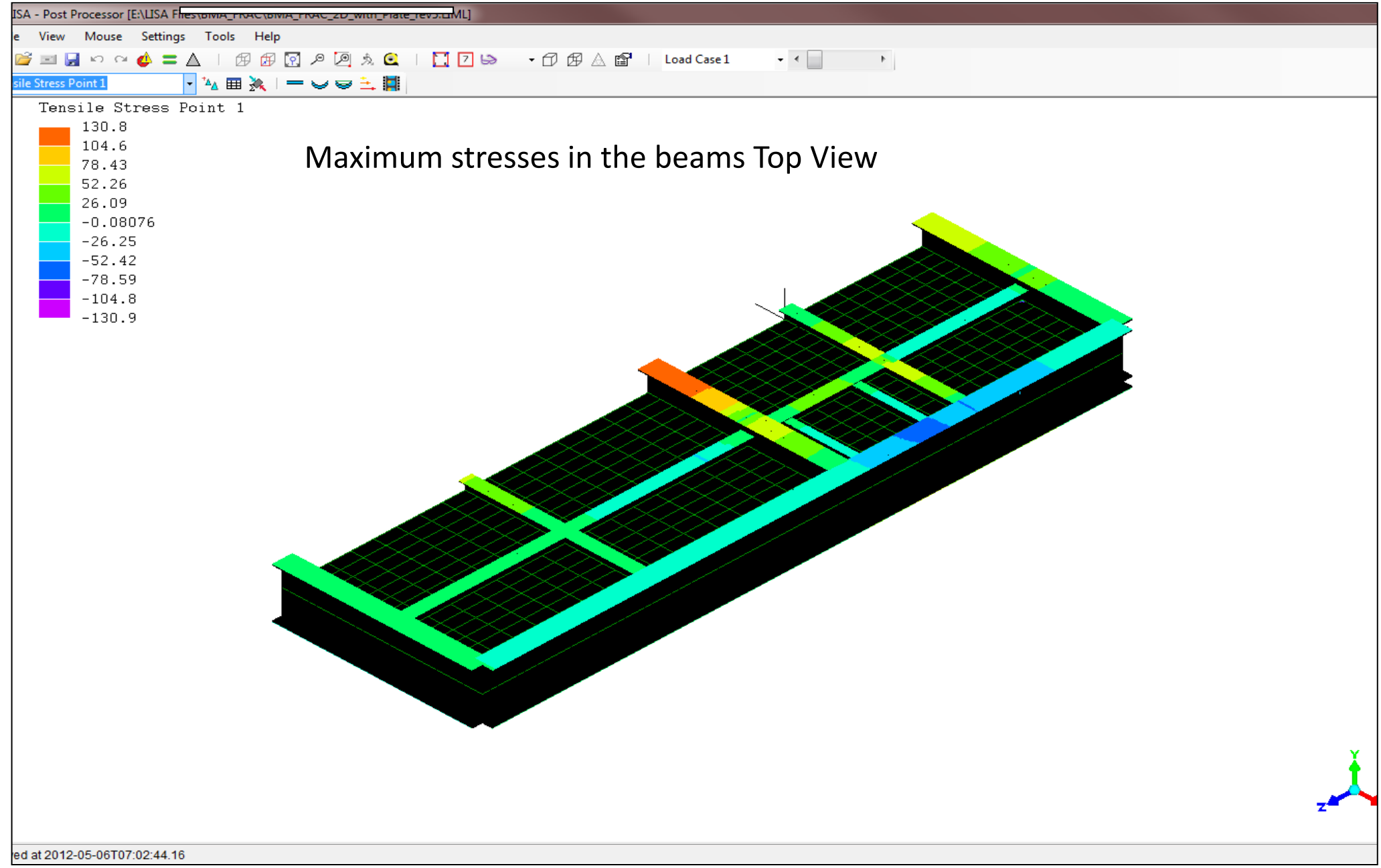


Cut out of the Von-misses stresses on the plate



Plot of Von-Misses Stresses on the underside of the plate

Maximum stresses in the beams Top View



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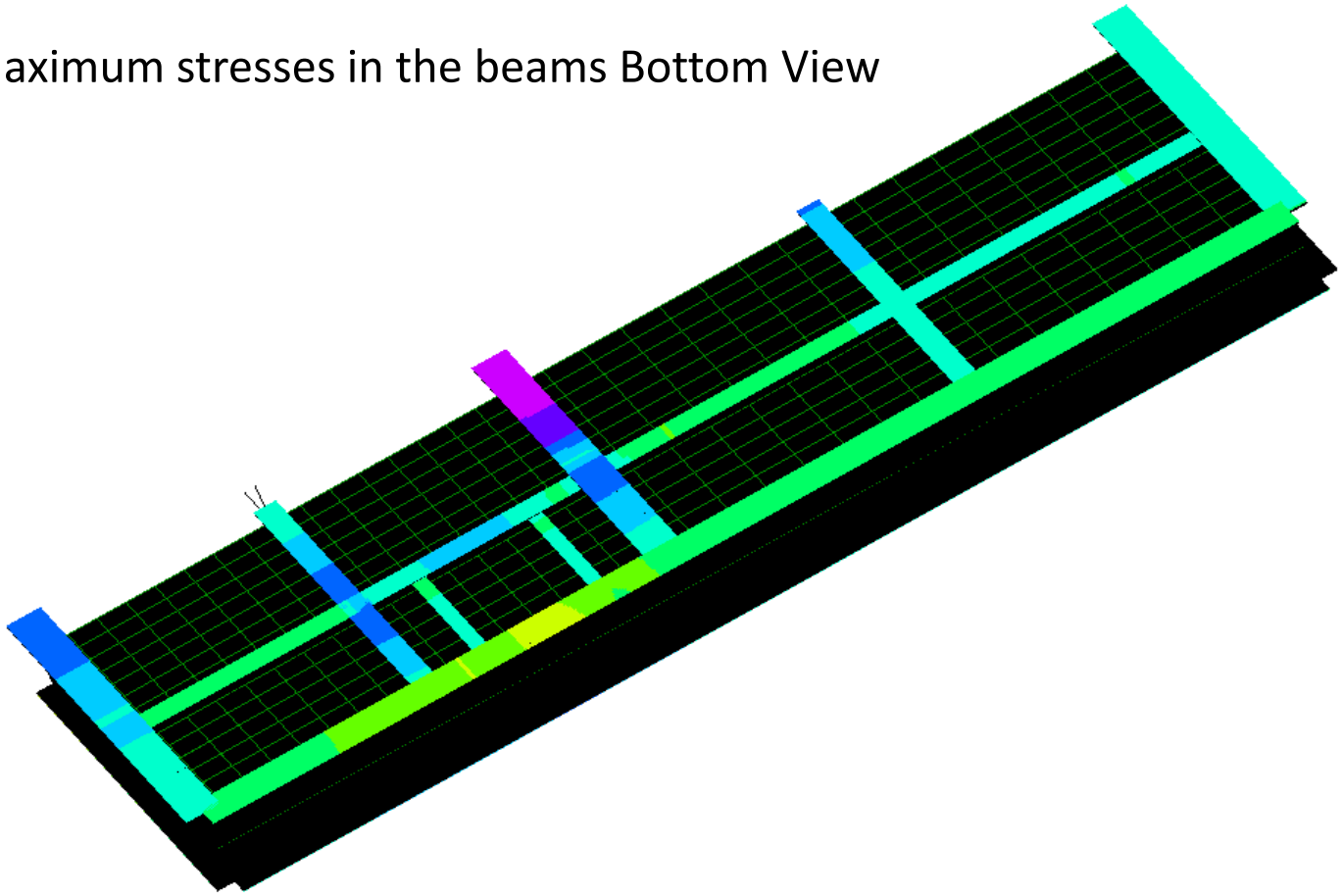
Load Case 1

Tensile Stress Point 1

Tensile Stress Point 1

130.8
104.6
78.43
52.26
26.09
-0.08076
-26.25
-52.42
-78.59
-104.8
-130.9

Maximum stresses in the beams Bottom View



Solved at 2012-05-06T07:02:44.16

Maximum Displacement Plot due to self-weight only