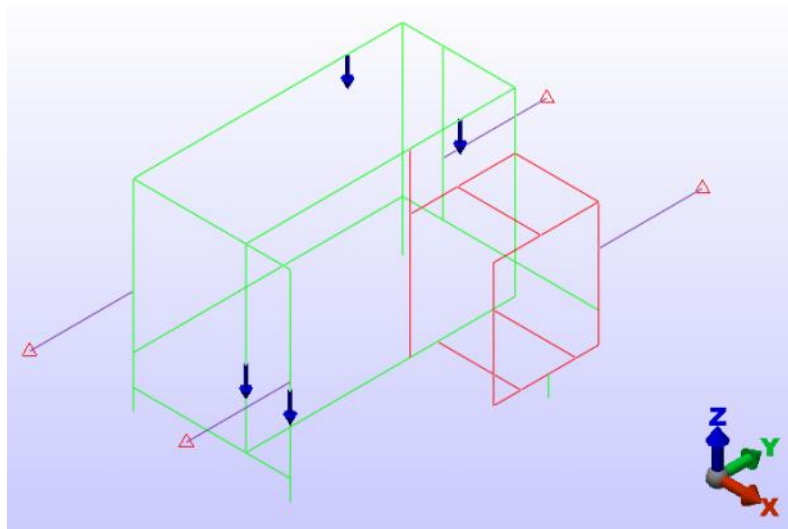


### ANEXO 3



. Fig. 6: DCL de la estructura cargada con su propio peso.

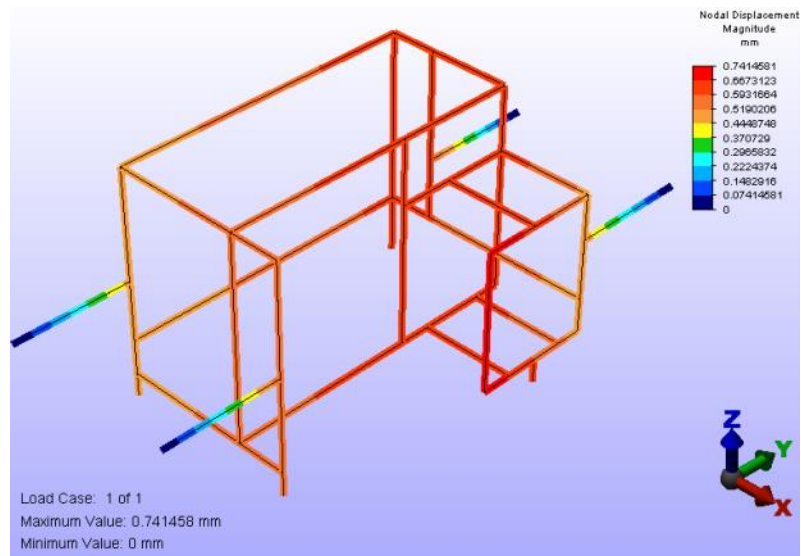
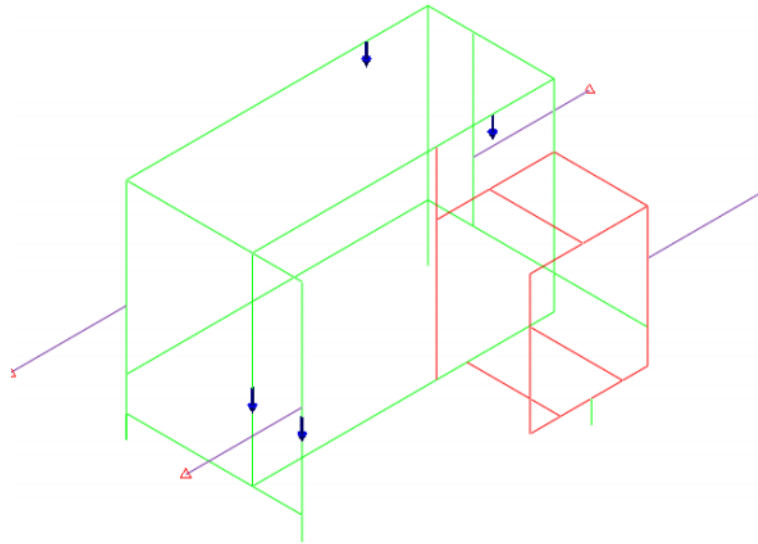


Fig. 7: Desplazamiento de la estructura cargada con su propio peso.

## RESUMEN DE INFORMACIÓN DEL PROCESO DE CÁLCULO EN EL SOFTWARE



Design Analysis



Project created on DateTime no válido..  
Last updated on 27/11/2007.

Project checked on 27/11/2007.

## Summary

### Model Information

Analysis Type - Static Stress with Linear Material Models  
Units - Custom - (N, mm, s, deg C, K, V, ohm, A, J)  
Model location - D:\IVAN\ALGOR\CURSO  
2007\tesis\Estructura\Estructura\_Deformaciones

## Analysis Parameters Information

### Load Case Multipliers

Static Stress with Linear Material Models may have multiple load cases. This allows a model to be analyzed with multiple loads while solving the equations a single time. The following is a list of load case multipliers that were analyzed with this model.

<b>Load Case</b>	<b>Pressure/Surface Forces</b>	<b>Acceleration/Gravity</b>	<b>Displaced Boundary</b>	<b>Thermal</b>	<b>Voltage</b>
1	0	1	0	0	0

## Gravity Information

The following lists the values used if acceleration or gravity was included in the analysis. The Acceleration/Gravity direction multiplier is multiplied by the Acceleration Due To Body Force which is then multiplied by the Acceleration/Gravity load case multiplier.

**Acceleration Due To Body Force = 9814.56 mm/s<sup>2</sup>**

<b>Acceleration/Gravity X Multiplier</b>	<b>Acceleration/Gravity Y Multiplier</b>	<b>Acceleration/Gravity Z Multiplier</b>
0	0	-1

## Multiphysics Information

Default Nodal Temperature                      0 °C  
 Source of Nodal Temperature                      None  
 Time step from Heat Transfer Analysis      Last

## Processor Information

Type of Solver    Sparse  
 Disable Calculation and Output of Strains      No  
 Calculate Reaction Forces                              No  
 Invoke Banded Solver                                      Yes  
 Avoid Bandwidth Minimization                      No  
 Stop After Stiffness Calculations                      No  
 Displacement Data in Output File                      No  
 Stress Data in Output File                              No  
 Equation Numbers Data in Output File              No  
 Element Input Data in Output File                      No  
 Nodal Input Data in Output File                      No

Centrifugal Load Data in Output File      No

## Part Information

Part ID	Part Name	Element Type	Material Name
<a href="#">1</a>	Part 1	Beam	<a href="#">Steel (ASTM-A36)</a>
<a href="#">2</a>	Part 2	Beam	<a href="#">Steel (ASTM-A36)</a>
<a href="#">3</a>	Part 3	Beam	<a href="#">Steel (ASTM-A36)</a>

### Element Properties used for:

- Part 1

Element Type    Beam  
Section 1 - Area    339.99932  
Section 1 - SA2    0  
Section 1 - SA3    0  
Section 1 - J1    2913.6199792  
Section 1 - I2    45785.456816  
Section 1 - I3    45785.456816  
Section 1 - S2    1704.254656  
Section 1 - S3    1704.254656

### Element Properties used for:

- Part 2

Element Type    Beam  
Section 1 - Area    150.96744  
Section 1 - SA2    0  
Section 1 - SA3    0  
Section 1 - J1    416.2314256  
Section 1 - I2    9157.0913632  
Section 1 - I3    9157.0913632  
Section 1 - S2    507.998984  
Section 1 - S3    507.998984

### Element Properties used for:

- Part 3

Element Type    Beam  
 Section 1 - Area    157.5  
 Section 1 - SA2    0  
 Section 1 - SA3    0  
 Section 1 - J1    23700  
 Section 1 - I2    11850  
 Section 1 - I3    11850  
 Section 1 - S2    894.3  
 Section 1 - S3    894.3

## Material Information

### Steel (ASTM-A36)

Material Model    Standard  
 Material Source    Algor Material Library  
 Material Source File    C:\ARCHIV~1\ALGOR\MatLibs\algormat.mlb  
 Date Last Updated    1999/06/02-11:03:56  
 Material Description    Structural Steel Mechanics of Materials, 2nd Edition, F.P. Beer and E.R. Johnston, Jr. (mechanical)  
 Mass Density    0.0000000078548 N\*s<sup>2</sup>/mm/mm<sup>3</sup>  
 Modulus of Elasticity    199950 N/mm<sup>2</sup>  
 Poisson's Ratio    0.29

## Load and Constraint Information

### Loads

#### Load Set 1: Unnamed

#### Nodal Forces

ID	Description	Node	Magnitude	Vx	Vy	Vz	Load Coordinate
----	-------------	------	-----------	----	----	----	-----------------

		ID					Case	System ID
1	Unnamed	44	-27.8	0	0	1	1	0
2	Unnamed	45	-27.8	0	0	1	1	0
3	Unnamed	34	-46.05	0	0	1	1	0
4	Unnamed	35	-46.05	0	0	1	1	0

## Constraints

### Constraint Set 1: Unnamed

#### Nodal Boundary Conditions

ID	Description	Node ID	Tx	Ty	Tz	Rx	Ry	Rz
9	Unnamed	38	Yes	Yes	Yes	Yes	Yes	Yes
10	Unnamed	39	Yes	Yes	Yes	Yes	Yes	Yes
11	Unnamed	41	Yes	Yes	Yes	Yes	Yes	Yes
12	Unnamed	43	Yes	Yes	Yes	Yes	Yes	Yes

## Processor Output

### Processor Summary

ALGOR (R) Static Stress with Linear Material Models  
Version 12.32-WIN 27-JUN-2003  
Copyright (c) 1984-2003 ALGOR, Inc. All rights reserved.

DATE: NOVEMBER 27,2007  
TIME: 05:13 PM  
INPUT MODEL: D:\IVAN\ALGOR\CURSO  
2007\tesis\Estructura\Estructura\_Deformaciones  
ALG.DLL VERSION:13240000

-----  
Structural

1\*\*\*\* CONTROL INFORMATION

number of node points	(NUMNP)	=	51
number of element types	(NELTYP)	=	3
number of load cases	(LL)	=	1
number of frequencies	(NF)	=	0
analysis type code	(NDYN)	=	0

equations per block (KEQB) = 0  
 bandwidth minimization flag (MINBND) = 0  
 gravitational constant (GRAV) = 9.8146E+03

\*\*\*\* PRINT OF NODAL DATA SUPPRESSED  
 \*\*\*\* PRINT OF EQUATION NUMBERS SUPPRESSED  
 \*\*\*\* PRINT OF TYPE-2 ELEMENT DATA SUPPRESSED  
 \*\*\*\* PRINT OF TYPE-2 ELEMENT DATA SUPPRESSED  
 \*\*\*\* PRINT OF TYPE-2 ELEMENT DATA SUPPRESSED  
 \*\*\*\* Hard disk file size information for processor:

Available hard disk space on current drive = 17662.457 megabytes

1\*\*\*\* NODAL LOADS (STATIC) OR MASSES (DYNAMIC)

NODE	LOAD	X-AXIS	Y-AXIS	Z-AXIS	X-AXIS	Y-AXIS	
Z-AXIS	NUMBER	CASE	FORCE	FORCE	FORCE	MOMENT	MOMENT
MOMENT							
	34	1	0.000E+00	0.000E+00	-4.605E+01	0.000E+00	0.000E+00
0.000E+00							
	35	1	0.000E+00	0.000E+00	-4.605E+01	0.000E+00	0.000E+00
0.000E+00							
	44	1	0.000E+00	0.000E+00	-2.780E+01	0.000E+00	0.000E+00
0.000E+00							
	45	1	0.000E+00	0.000E+00	-2.780E+01	0.000E+00	0.000E+00
0.000E+00							

1\*\*\*\* ELEMENT LOAD MULTIPLIERS

load case	case A	case B	case C	case D	
case E					
-----	-----	-----	-----	-----	
-----					
	1	0.000E+00	1.000E+00	0.000E+00	0.000E+00
0.000E+00					

\*\*\*\* Invoking Sparse Solver ...

\*\*\*\* Symbolic Assembling Using the Row-Hits Matrix Profile ...

\*\*\*\* Assembled in One Block.

\*\*\*\* Real Sparse Matrix Assembly ...

1\*\*\*\* STIFFNESS MATRIX PARAMETERS

minimum non-zero diagonal element = 2.6938E+03  
 maximum diagonal element = 1.3316E+09  
 maximum/minimum = 4.9432E+05  
 average diagonal element = 1.1840E+08

in the upper off-diagonal matrix:  
 number of entries in the profile = 3558  
 number of symbolic nonzero entries = 2523  
 number of real nonzero entries = 692

\*\*\*\* Sparse Matrix Assembled in One Block

\*\*\*\* Load case 1

\*\*\*\* Sparse Matrix Factorization ...

Completing in-core sparse solution

\*\*\*\* Sparse Matrix Solving ...  
 \*\*\*\* End Sparse Matrix Solution

Reaction Sums and Maxima for Load Case 1

Sum of applied forces  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 0.0000E+00 0.0000E+00 -5.4795E+02 0.0000E+00 0.0000E+00  
 0.0000E+00

Sum of reactions  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 8.8818E-16 -1.0658E-14 -3.5527E-14 -2.1556E+03 -1.7789E+02 -  
 4.4591E+03

Sum of residuals  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 8.8818E-16 -1.0658E-14 -5.4795E+02 -2.1556E+03 -1.7789E+02 -  
 4.4591E+03

Sum of unfixed direction residuals  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 1.8529E-11 1.1994E-11 -3.9402E-10 -1.7434E-09 1.0270E-09  
 8.8291E-11

Largest applied forces and moments  
 Node Node Node Node Node  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 0 0 34 0 0  
 0  
 0.0000E+00 0.0000E+00 -5.6272E+01 0.0000E+00 0.0000E+00  
 0.0000E+00

Largest nodal reactions  
 Node Node Node Node Node  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 41 38 41 41 41  
 41  
 -3.9418E+00 2.4363E+01 -1.6679E+02 3.8959E+04 -3.0297E+02 -  
 1.3845E+03

Largest nodal residuals  
 Node Node Node Node Node  
 X-Force Y-Force Z-Force X-Moment Y-Moment  
 Z-Moment  
 41 38 41 41 41  
 41  
 -3.9418E+00 2.4363E+01 -1.6952E+02 3.8959E+04 -3.0297E+02 -  
 1.3845E+03

Largest unfixed direction residuals



Node	Node	Node	Node	Node	Node
Z-Moment	X-Force	Y-Force	Z-Force	X-Moment	Y-Moment
15	35	24	36	27	4
	1.3195E-11	2.1888E-11	-3.2605E-10	-5.3194E-10	4.0737E-10
	4.0649E-11				

1\*\*\*\* TEMPORARY FILE STORAGE (MEGABYTES)

```

-----
UNIT NO. 7 : 0.002
UNIT NO. 8 : 0.002
UNIT NO. 9 : 0.000
UNIT NO. 10 : 0.000
UNIT NO. 11 : 0.004
UNIT NO. 12 : 0.002
UNIT NO. 13 : 0.002
UNIT NO. 14 : 0.000
UNIT NO. 15 : 0.000
UNIT NO. 17 : 0.000
UNIT NO. 51 : 0.004
UNIT NO. 52 : 0.060
UNIT NO. 54 : 0.001
UNIT NO. 55 : 0.003
UNIT NO. 56 : 0.005
UNIT NO. 58 : 0.002

TOTAL : 0.087 Megabytes

```

## Processor Log

ALGOR (R) Static Stress with Linear Material Models  
Version 12.32-WIN 27-JUN-2003  
Copyright (c) 1984-2003 ALGOR, Inc. All rights reserved.

Structural

```

51 3 1 0 0 0
**** Linear stress analysis
**** Memory Dynamically Allocated = 261528 KB

```

Options executed are:

```

NOMIN
STRAIN
SPARSE
SUPCNF
SUPELM
SUPNOD
REAC
ENOR

```

processing ...

```

**** OPENING TEMPORARY FILES
      NDYN = 0

      DATE: NOVEMBER 27,2007
      TIME: 05:13 PM
      INPUT MODEL: D:\IVAN\ALGOR\CURSO
2007\tesis\Estructura\Estructura_Deformaciones
      ALG.DLL VERSION:13240000

**** BEGIN NODAL DATA INPUT
      51 NODES
**** END   NODAL DATA INPUT
**** BEGIN TYPE-2 DATA INPUT
      35 ELEMENTS
**** END   TYPE-2 DATA INPUT
**** BEGIN TYPE-2 DATA INPUT
      18 ELEMENTS
**** END   TYPE-2 DATA INPUT
**** BEGIN TYPE-2 DATA INPUT
      4 ELEMENTS
**** END   TYPE-2 DATA INPUT
**** Hard disk file size information for processor:

      Available hard disk space on current drive = 17662.457
megabytes

**** BEGIN LOAD INPUT
      Load factor = 1.00E+00 in the 2nd basket in load case 1
**** END   LOAD INPUT

**** Invoking Sparse Solver ...

**** Symbolic Assembling Using the Row-Hits Matrix Profile ...
**** Assembled in One Block.
**** Real Sparse Matrix Assembly ...
      in the upper off-diagonal matrix:
      number of entries in the profile = 3558
      number of symbolic nonzero entries= 2523
      number of real nonzero entries   = 692
**** Sparse Matrix Assembled in One Block
**** Load case 1
**** Sparse Matrix Factorization ...
**** Sparse Matrix Solving ...
**** End Sparse Matrix Solution

**** BEGIN DISPLACEMENT OUTPUT
**** PRINT OF DISPLACEMENT OUTPUT SUPPRESSED
**** END   DISPLACEMENT OUTPUT
**** BEGINNING REACTION COMPUTATIONS
**** LOADCASES REMAINING      1
**** BLOCKS REMAINING        1
**** GROUPS REMAINING        3
**** GROUP USED--ELEMENT/GLOBAL CONTRIBUTIONS
      35 ELEMENTS
      35 ELEMENTS REMAINING
      30 ELEMENTS REMAINING
      20 ELEMENTS REMAINING
      10 ELEMENTS REMAINING
**** GROUPS REMAINING      2
**** GROUP USED--ELEMENT/GLOBAL CONTRIBUTIONS

```

```
18 ELEMENTS
  18 ELEMENTS REMAINING
  10 ELEMENTS REMAINING
**** GROUPS REMAINING      1
**** GROUP USED--ELEMENT/GLOBAL CONTRIBUTIONS
  4 ELEMENTS
  4 ELEMENTS REMAINING
**** ENDING REACTION COMPUTATIONS
```

```
Estructura_Deformaciones.t7 = 1.930 kilobytes
Estructura_Deformaciones.t8 = 2.480 kilobytes
Estructura_Deformaciones.t9 = 0.000 kilobytes
Estructura_Deformaciones.t10 = 0.000 kilobytes
Estructura_Deformaciones.t11 = 3.750 kilobytes
Estructura_Deformaciones.t12 = 1.922 kilobytes
Estructura_Deformaciones.t13 = 1.930 kilobytes
Estructura_Deformaciones.t14 = 0.000 kilobytes
Estructura_Deformaciones.t15 = 0.000 kilobytes
Estructura_Deformaciones.t17 = 0.000 kilobytes
Estructura_Deformaciones.t51 = 4.453 kilobytes
Estructura_Deformaciones.t52 = 61.898 kilobytes
Estructura_Deformaciones.t54 = 0.984 kilobytes
Estructura_Deformaciones.t55 = 2.703 kilobytes
Estructura_Deformaciones.t56 = 5.406 kilobytes
Estructura_Deformaciones.t58 = 1.922 kilobytes
```

total temporary disk storage (megabytes) = .08728

```
Estructura_Deformaciones.l = 6.455 kilobytes
Estructura_Deformaciones.do = 2.438 kilobytes
```

```
**** BEGIN DELETING TEMPORARY FILES
Processing completed for model:
[D:\IVAN\ALGOR\CURSO
2007\tesis\Estructura\Estructura_Deformaciones]
**** TEMPORARY FILES DELETED
**** END OF SUCCESSFUL EXECUTION
```

Total actual hard disk space used = 0.096 megabytes

Sub-total elapsed time = 0.012 minutes

ALGOR (R) Stress Calculation Utility  
Version 12.16-WIN 25-APR-2003  
Copyright (c) 1989-2003 ALGOR, Inc. All rights reserved.

```
**** Memory Dynamically Allocated = 261528 KB
Percent capacity: .005828
```

```
DATE: NOVEMBER 27,2007
TIME: 05:13 PM
INPUT.....D:\IVAN\ALGOR\CURSO
2007\tesis\Estructura\Estructura_Deformaciones
Percent capacity: .005831
Percent capacity: .005831
**** BEGIN TYPE-2 DATA INPUT
```

```

35 ELEMENTS
Percent capacity: .006178
    0 elements remaining
**** END TYPE-2 DATA INPUT
**** BEGIN TYPE-2 DATA INPUT
18 ELEMENTS
Percent capacity: .006178
    0 elements remaining
**** END TYPE-2 DATA INPUT
**** BEGIN TYPE-2 DATA INPUT
4 ELEMENTS
Percent capacity: .006178
    0 elements remaining
**** END TYPE-2 DATA INPUT
Percent capacity: .005837
**** Writing stress and strain output files ...
    0 load cases remaining
**** Hard disk file size information for postprocessor:
Estructura_Deformaciones.son = 10.098 kilobytes
Estructura_Deformaciones.nso = 4.531 kilobytes
Estructura_Deformaciones.sto = 4.531 kilobytes

Total MKNSO disk space used = 0.01871 megabytes
**** End of successful execution
**** MKNSO elapsed time = 0.002 minutes

**** The TOTAL elapsed time = 0.014 minutes

```

## Stress Analysis

The stress analysis output file (D:\IVAN\ALGOR\CURSO 2007\tesis\Estructura\Estructura\_Deformaciones.S) was not found.

## Weight and Center of Gravity Analysis

The weight and center of gravity analysis output file (D:\IVAN\ALGOR\CURSO 2007\tesis\Estructura\Estructura\_Deformaciones.WCG) was not found.

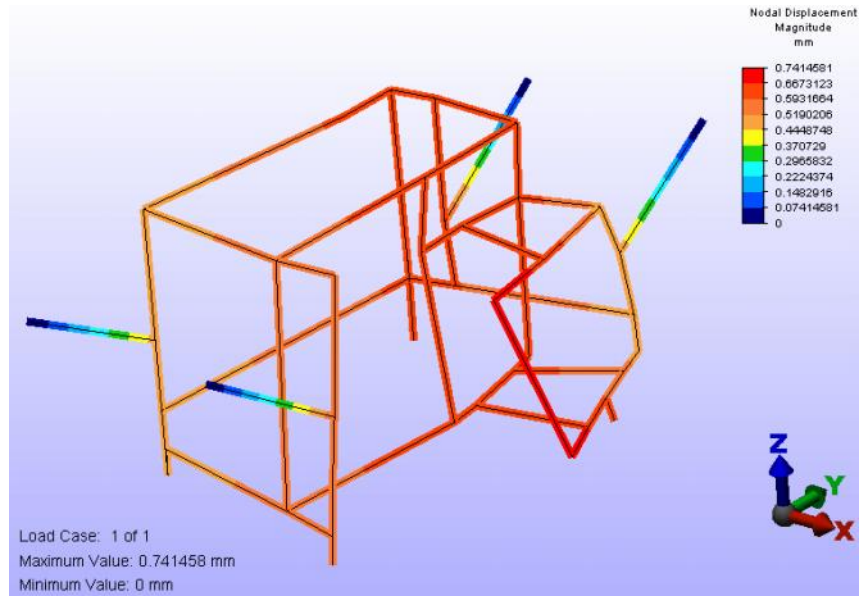


Fig. 8: Desplazamiento de la estructura cargada con su propio peso a nueve veces la escala real.

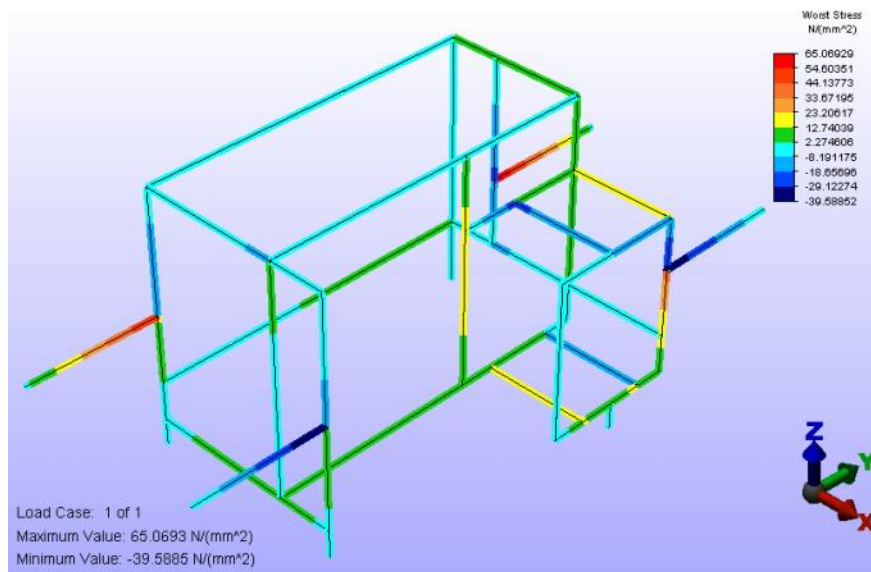


Fig. 9: Esfuerzo de la estructura cargada con su propio peso.