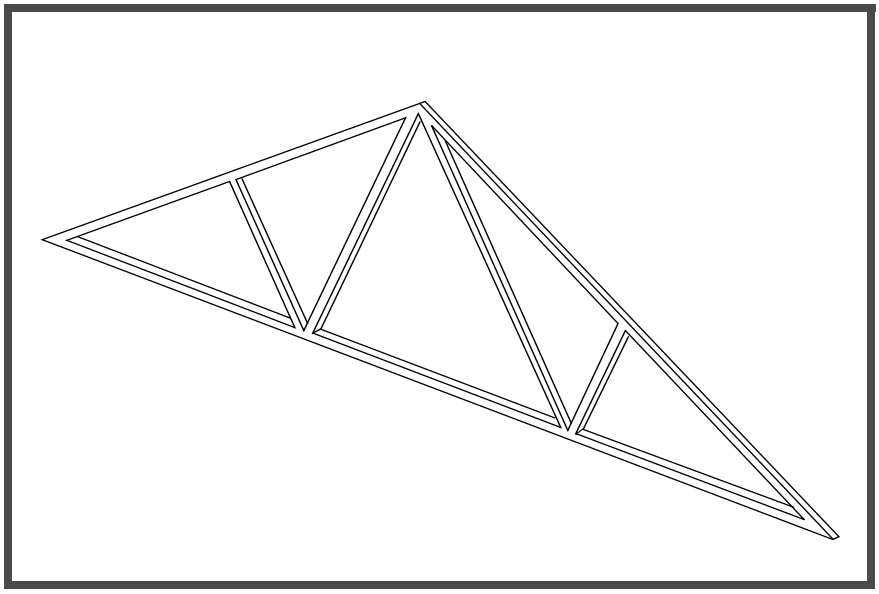
APPENDIX C

Linear Static Analysis of a Simply-Supported Truss (SI)



Objectives:

- Create a MSC.Nastran model comprised of CROD elements.
- Prepare a MSC.Nastran input file for a Linear Static analysis.
- Visualize analysis results.

Model Description:

Below is a finite element representation of the truss structure shown on page C-1. The nodal coordinates provided are defined in the MSC.Nastran Basic system.

The structure is comprised of truss segments connected by smooth pins such that each segment is either in tension or compression. The structure has a pinned support at Grid Point 1 and is supported by a roller at Grid Point 7. Point forces are applied at Grid Points 2, 4, and 6. In addition, out of plane translations and all rotations shall be constrained for all Grids.

HINT: DOF 3456 for Grid 1 through 7 can be constrained by using the permanent single point constraint option in the GRID entry.

Figure C.1 - Grid Coordinates and Element Connectivities

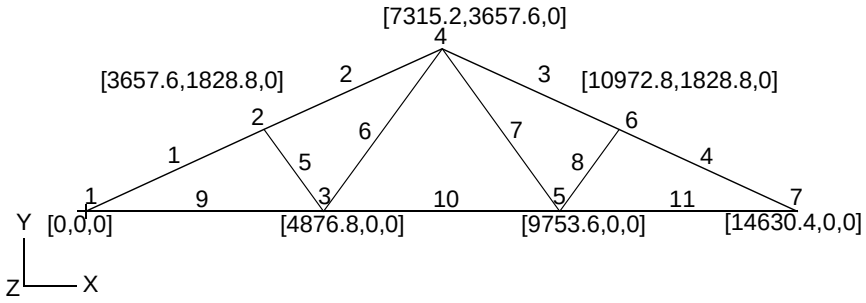


Figure C.2 - Loads and Boundary Conditions

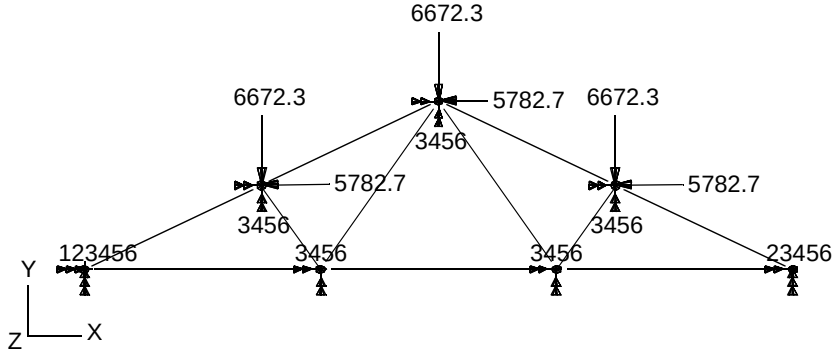


Table C.1 - Model Properties

Cross-Sectional Area:	**3387.1 mm^2**
Elastic Modulus:	**12.1 GPa**
Poisson Ratio:	**0.3**
Tension Stress Limit:	**13.1 Pa**
Compression Stress Limit:	**13.1 Pa**

Suggested Exercise Steps:

- Build the truss geometry as shown in Figure 1.1 on the XY plane
- Generate a finite element representation of the truss structure using (GRID) and (CROD) elements. Size elements to match Figure C.1. Actual node ID's and element ID's may vary.
  (**HINT:** Remember to use permanent constraints for DOF 3456.)
- Define material (MAT1) and element (PROD) properties.
- Apply simply-supported boundary constraints (SPC1) and point forces (FORCE).
- Prepare the model for a linear static analysis (SOL 101).
- Submit it for a linear static analysis.
- Review results.

Generating an Input File for MSC.Nastran Users:

1. MSC.Nastran users can generate an input file using the data from page C-3. The result should be similar to the output below (**ex01truss.dat**):

```
ID  EXERCISE,CATIAFEM
SOL     101
CEND
$..
$-------------------------------------------------------------------------------
$..
$..                    CASE CONTROL DECK
$..
TITLE = EXERCISE 1
DISPL   =       ALL
ELSTRESS=       ALL
SPCFORCE=       ALL
MPC     =       1
$..
SUBCASE =        1
$ CATIA RESTRAINT SET NAME :
$ RESTRAINT1
   SPC  =        1
$ CATIA LOAD SET NAME :
$ LOAD1
   LOAD =        1
$..
$-------------------------------------------------------------------------------
$..
$..                    BULK DATA CARDS
$..
BEGIN BULK
PARAM   POST    -1
PARAM   AUTOSPC YES
$..
$-------------------------------------------------------------------------------
$..
$..                    RESTRAINTS
$..
$ NASTRAN ID =        1 / RESTRAINT SET NAME :
$ RESTRAINT1
SPC1    1       3456    2       3       4       5       6
SPC1    1       123456  1
SPC1    1       23456   7
$..
$-------------------------------------------------------------------------------
$..
$..                    LOADS
$..
$ NASTRAN ID =        1 / LOAD SET NAME :
$ LOAD1
FORCE   1       2               6672.3  0.      -1.     0.
FORCE   1       4               6672.3  0.      -1.     0.
FORCE   1       6               6672.3  0.      -1.     0.
FORCE   1       2               5782.701-1.     0.      0.
FORCE   1       4               5782.701-1.     0.      0.
```

```
FORCE   1       6               5782.701-1.     0.      0.
$..
$-------------------------------------------------------------------------------
$..
$..                     NODES
$..
GRID    1               0.      0.      0.
GRID    2               3657.6  1828.8  0.
GRID    3               4876.8  0.      0.
GRID    4               7315.2  3657.6  0.
GRID    5               9753.6  0.      0.
GRID    6               10972.8 1828.8  0.
GRID    7               14630.4 0.      0.
$..
$-------------------------------------------------------------------------------
$..
$..                     ELEMENTS
$..
CROD    1       1       1       2
CROD    2       1       2       4
CROD    3       1       4       6
CROD    4       1       6       7
CROD    5       1       2       3
CROD    6       1       3       4
CROD    7       1       4       5
CROD    8       1       5       6
CROD    9       1       1       3
CROD    10      1       3       5
CROD    11      1       5       7
$..
$-------------------------------------------------------------------------------
$..
$..                     PROPERTIES
$..
PROD    1       1       3387.1
$..
$-------------------------------------------------------------------------------
$..
$..                     MATERIALS
$..
$ MATERIAL NAME : TRUSS MAT
MAT1    1       12100.          .3                                              1
+       113.1   13.1
$..
ENDDATA
```

Submitting the Input File for Analysis:

2. When the run is completed, edit the **ex01truss.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

3. While still editing **ex01truss.f06**, search for the word:

D I S P L A C E (spaces are necessary).

What are the components of the displacement vector for GRID 7 (translation only)?

Disp. X = _____

Disp. Y = _____

Disp. Z = _____

Search for the word:

S I N G L E (spaces are necessary).

What are the components of the reaction force at GRID 1?

Force X = _____

Force Y = _____

Force Z = _____

Search for the word:

S T R E S S (spaces are necessary).

What is the margin of safety for CROD 2?

M.S. = _____

What is the Axial Stress for CROD 7?

Axial Stress = _____

Comparison of Results:

4. Compare the results obtained in the **.f06** file with the results on the following page:

D I S P L A C E M E N T   V E C T O R

OINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	0.0	0.0	0.0	0.0	0.0	0.0
2	G	2.808579E+00	-1.205278E+01	0.0	0.0	0.0	0.0
3	G	1.005669E+00	-1.303506E+01	0.0	0.0	0.0	0.0
4	G	7.260538E-01	-1.240931E+01	0.0	0.0	0.0	0.0
5	G	1.561432E+00	-1.296366E+0	0.0	0.0	0.0	0.0
6	G	-9.064730E-01	-1.187403E+01	0.0	0.0	0.0	0.0
7	G	3.255203E+00	0.0	0.0	0.0	0.0	0.0

F O R C E S   O F   S I N G L E - P O I N T   C O N S T R A I N T

OINT ID.	TYPE	T1	T2	T3	R1	R2	R3
1	G	1.734810E+04	1.289980E+04	0.0	0.0	0.0	0.0
7	G	0.0	7.117099E+03	0.0	0.0	0.0	0.0

S T R E S S E S   I N   R O D   E L E M E N T S   (C R O D)

ELEMENT ID.	AXIAL STRESS	SAFETY MARGIN	TORSIONAL STRESS	SAFETY MARGIN	ELEMENT ID.	AXIAL STRESS	SAFETY MARGIN	TORSIONAL STRESS	SAFETY MARGIN
1	-8.516085E+00	5.4E-01	0.0		2	-5.983277E+00	1.2E+00	0.0	
3	-5.028883E+00	1.6E+00	0.0		4	-4.698508E+00	1.8E+00	0.0	
5	-1.006200E+00	1.2E+01	0.0		6	1.006200E+00	1.2E+01	0.0	
7	2.545115E+00	4.1E+00	0.0		8	-2.545115E+00	4.1E+00	0.0	
9	2.495201E+00	4.3E+00	0.0		10	1.378922E+00	8.5E+00	0.0	
11	4.202474E+00	2.1E+00	0.0						