MEG 795 COURSE PROJECT

**Transient dynamic analysis of a
3 Point Impact Hammer Test
on a simply supported steel plate
using ANSYS and LS-DYNA**

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TOPICS OF PRESENTATION

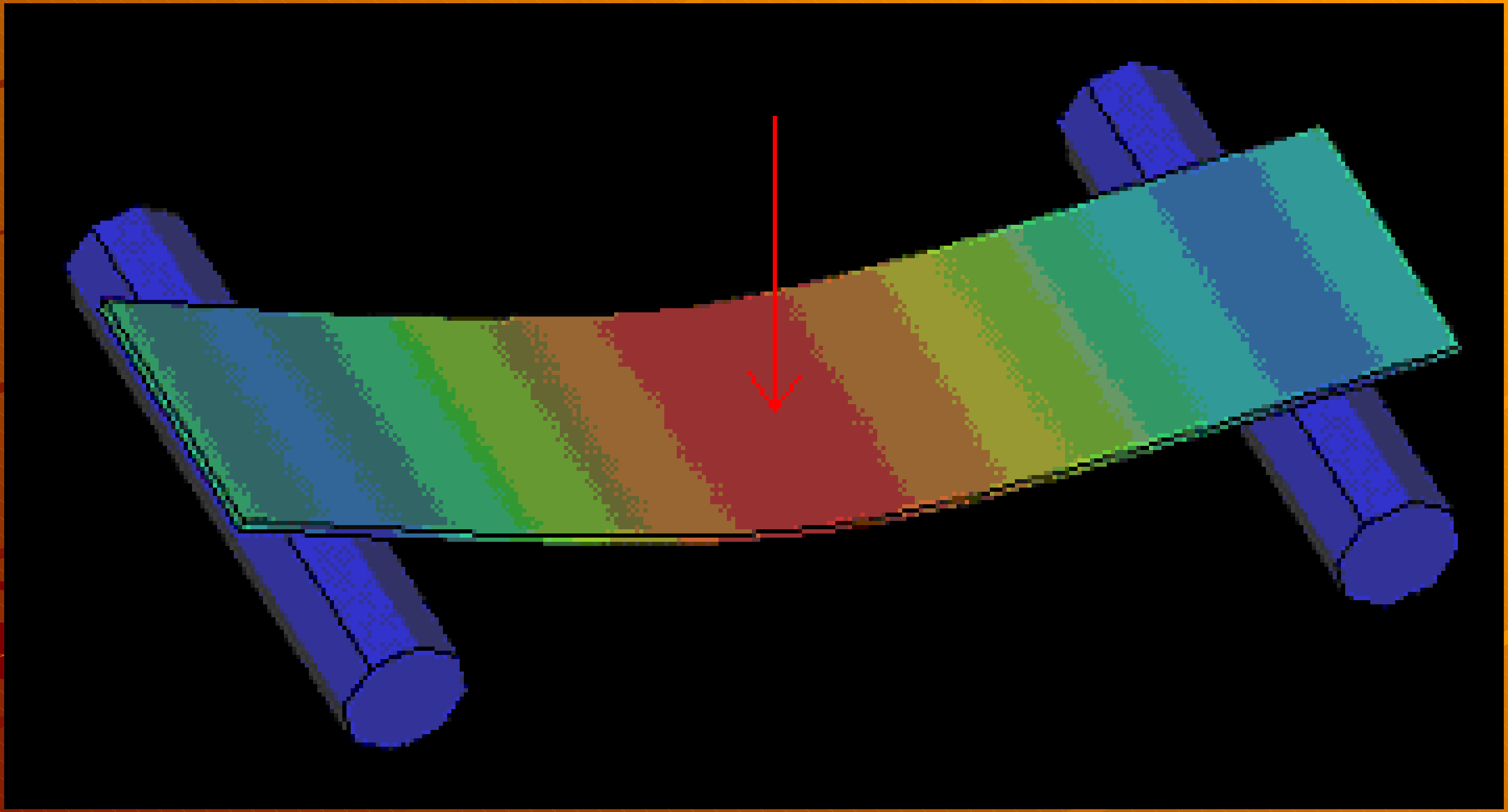
- INTRODUCTION
- MODEL GEOMETRY
- MESHING
- BOUNDARY CONDITIONS
- LOADING OPTIONS
- RESULTS
- CONCLUSION

INTRODUCTION

OBJECTIVES

1. Conduct an impact test on steel specimen
2. Observe material behavior
3. Construct a 3D model
4. Run transient dynamic analysis using
   a. ANSYS as pre-processor
   b. LSDYNA as solver
5. Compare the results and estimate the material properties.

3 POINT IMPACT TEST



MODEL GEOMETRY

RECTANGULAR STEEL PLATE

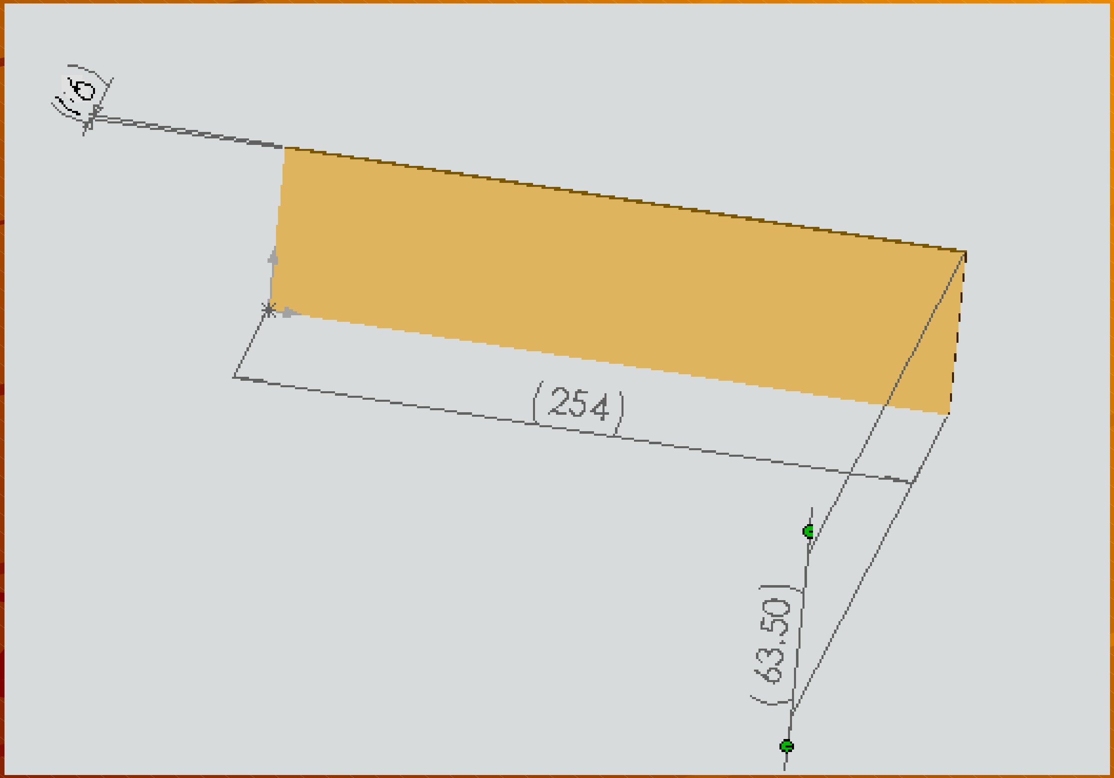


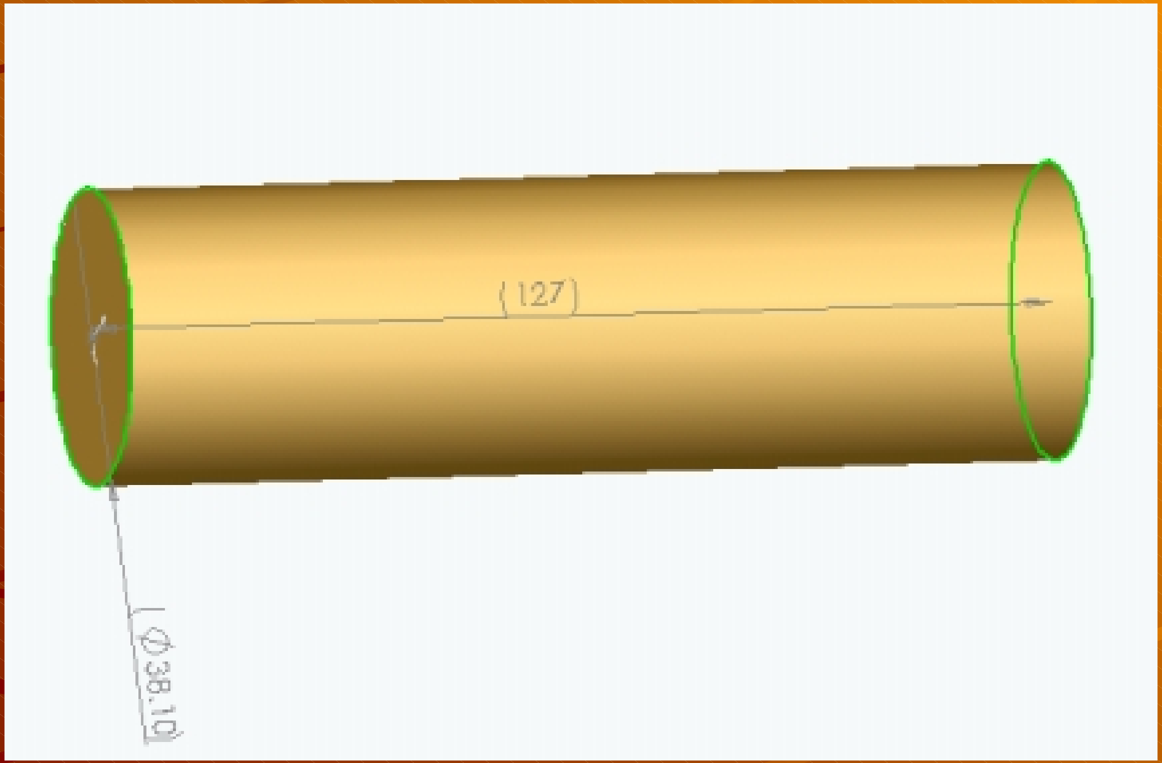
Plate Dimensions :

Length = 254 mm

Width = 63.5 mm

Thickness = 1.6 mm

ROLLER GEOMETRY

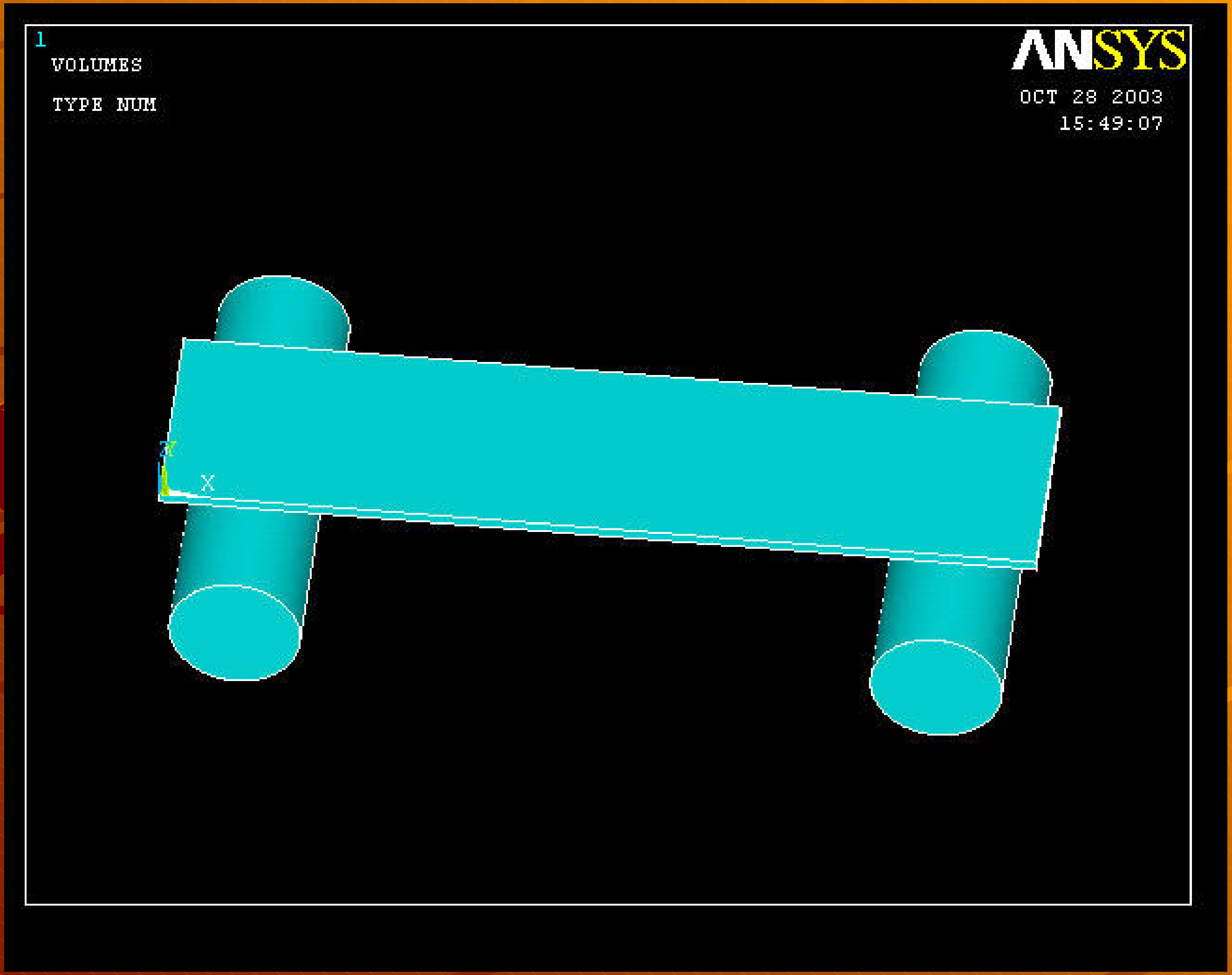


<u>Roller dimensions</u> :

Diameter = 38.1 mm

Height = 127 mm

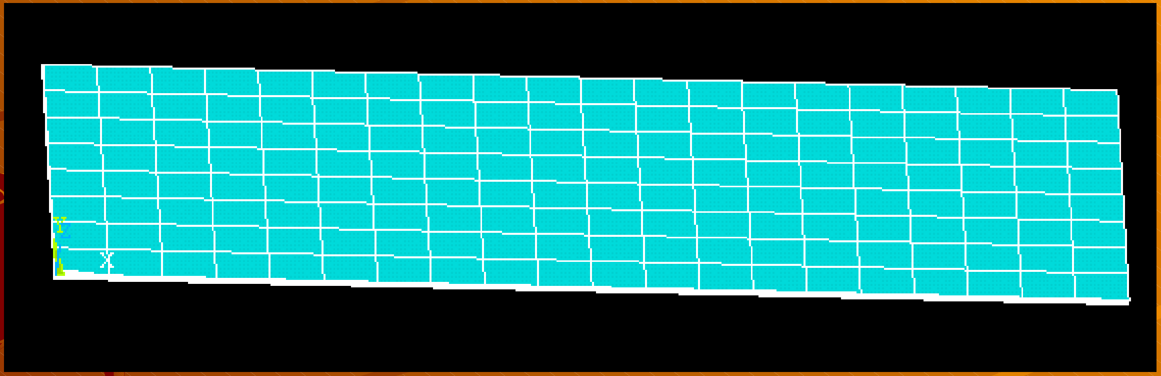
FULL MODEL GEOMETRY



MESHING

MESHED PLATE

Solid element 164 (Ls-Dyna Explicit) is used for meshing :

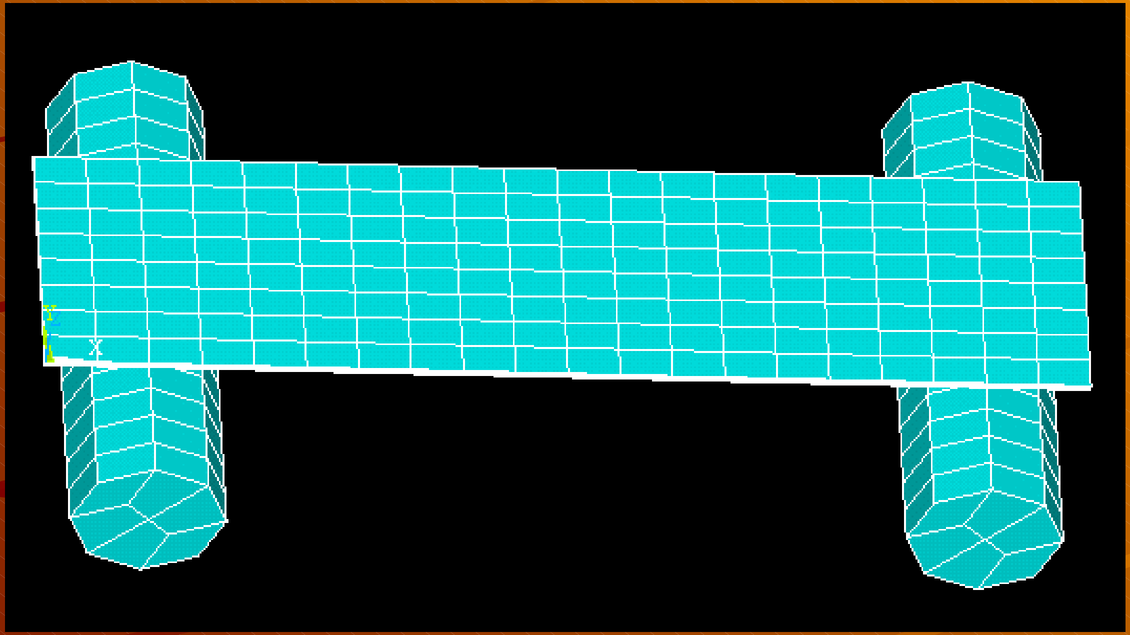


20 divisions along length

8 divisions along width

3 divisions along thickness

MESHED MODEL



Model consists of 3 parts:

1) Rectangular plate
2) Roller 1 (Left)
3) Roller 2 (Right)

MATERIAL PROPERTIES

System of units used : **S.I. units** -- N, mm, kg, second.

Material for steel plate	ASTM A36	ASTM A709
Young's Modulus (N/mm^2)	2e06	2e06
Poisson's Ratio	0.3	0.3
Density(kg/mm^3)	7.86e-06	7.86e-06
Tangent Modulus (N/mm^2)	77.2	77.2
Yield Strength(N/mm^2)	250	690

DEFINITION OF MATERIAL PROPERTIES USING CARDS IN .K FILE

1) **<u>FOR ASTM A36 (Low yield strength)</u>**

***MAT_PLASTIC_KINEMATIC**

1 0.780E-05 0.200E+06 0.300000 *<u>250.</u>* 77.2 0.00 0.00 0.00 0.00

***MAT_RIGID**

2 0.750E-05 0.200E+06 0.300000 0.0 0.0 0.0 1.00 7.00 7.00

***MAT_RIGID**

3 0.785E-05 0.207E+06 0.300000 0.0 0.0 0.0 1.00 7.00 7.00

2) FOR ASTMA709 (High yield strength)

*MAT_PLASTIC_KINEMATIC

1 0.780E-05 0.200E+06 0.300000 *690.* 77.2 0.00
0.00 0.00 0.00

*MAT_RIGID
2 0.750E-05 0.200E+06 0.300000 0.0 0.0 0.0
1.00 7.00 7.00

*MAT_RIGID
3 0.785E-05 0.207E+06 0.300000 0.0 0.0 0.0
1.00 7.00 7.00

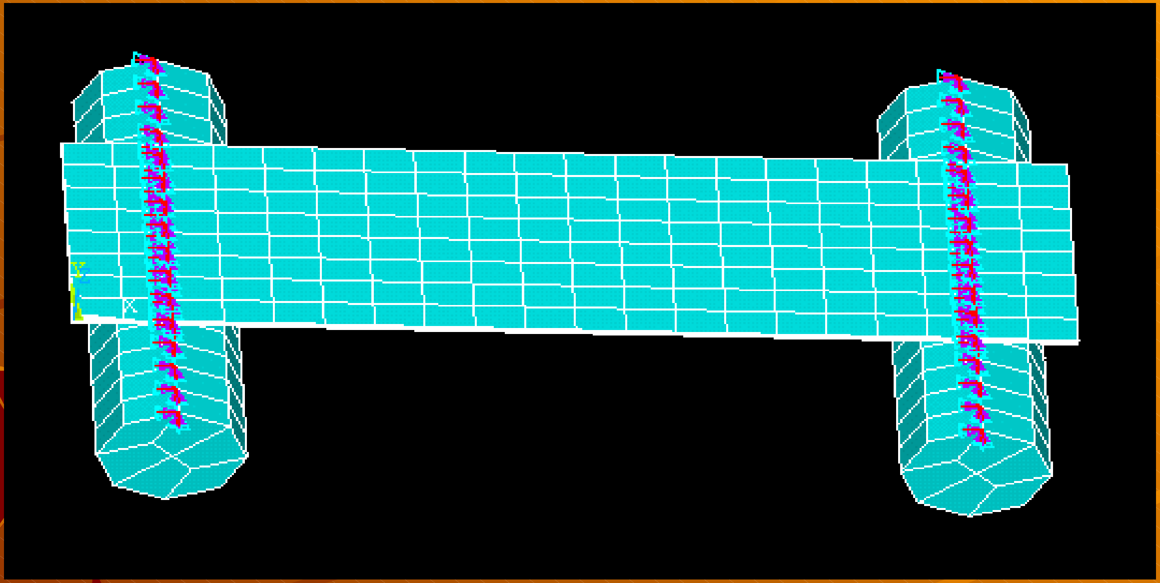
BOUNDARY CONDITIONS

ASSUMPTIONS :

The rollers are assumed to be rigid materials

The impact hammer load is assumed to be a distributed load , hence it is applied to 9 nodes around the center of the top surface

APPLICATION OF BOUNDARY CONDITIONS



1) The contact regions between the plate and the rollers (line) are constrained in all directions
2) Since the rollers are defined as rigid materials, they are not constrained at all

CONTACT ALGORITHMS

Defined using contact cards in .k file:

Part 1 – 2 (Steel plate – roller 1)

*CONTACT_SURFACE_TO_SURFACE

1 2 3 3 0 0 0 0

0.000 0.000 0.000 0.000 0.000 0 0.000 0.1000E+08

1.000 1.000 0.000 0.000 1.000 1.000 1.000 1.000

Part 1 -- 3 (Steel plate – roller 2)

*CONTACT_SURFACE_TO_SURFACE

1 3 3 3 0 0 0 0

0.000 0.000 0.000 0.000 0.000 0 0.000 0.1000E+08

1.000 1.000 0.000 0.000 1.000 1.000 1.000 1.000

LOADING OPTIONS

The impact load is applied in the negative z-direction using a load curve defined in .k file

- *DEFINE_CURVE

1	0	1.000	1.000	0.000	0.000

Time instant (sec)	Load applied (N)
0.00000000E+00	–3.49871000E+02
3.90000000E-04	–1.25488000E+01

RESULTS

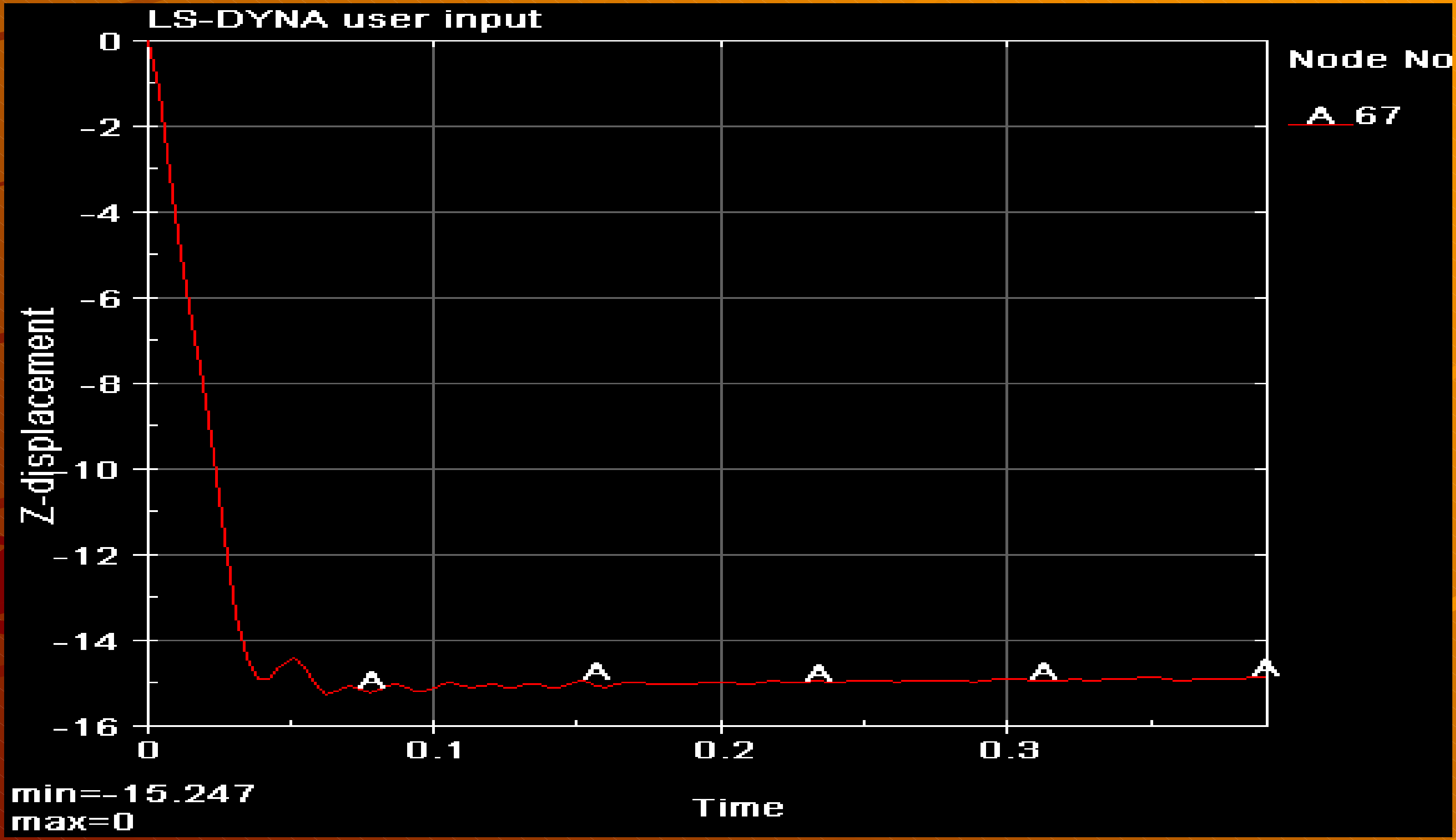
1. Deformations and stresses observed for material ASTM A36 (YS = 250 N/mm^2) ASTM A709(YS = 690 N/mm^2) and for YS = 500 N/mm^2 and YS = 600 N/mm^2

   (YS → Yield strength)

2. Comparison of experimental and analysis values

MATERIAL ASTMA36 (YS = 250 N/mm^2)

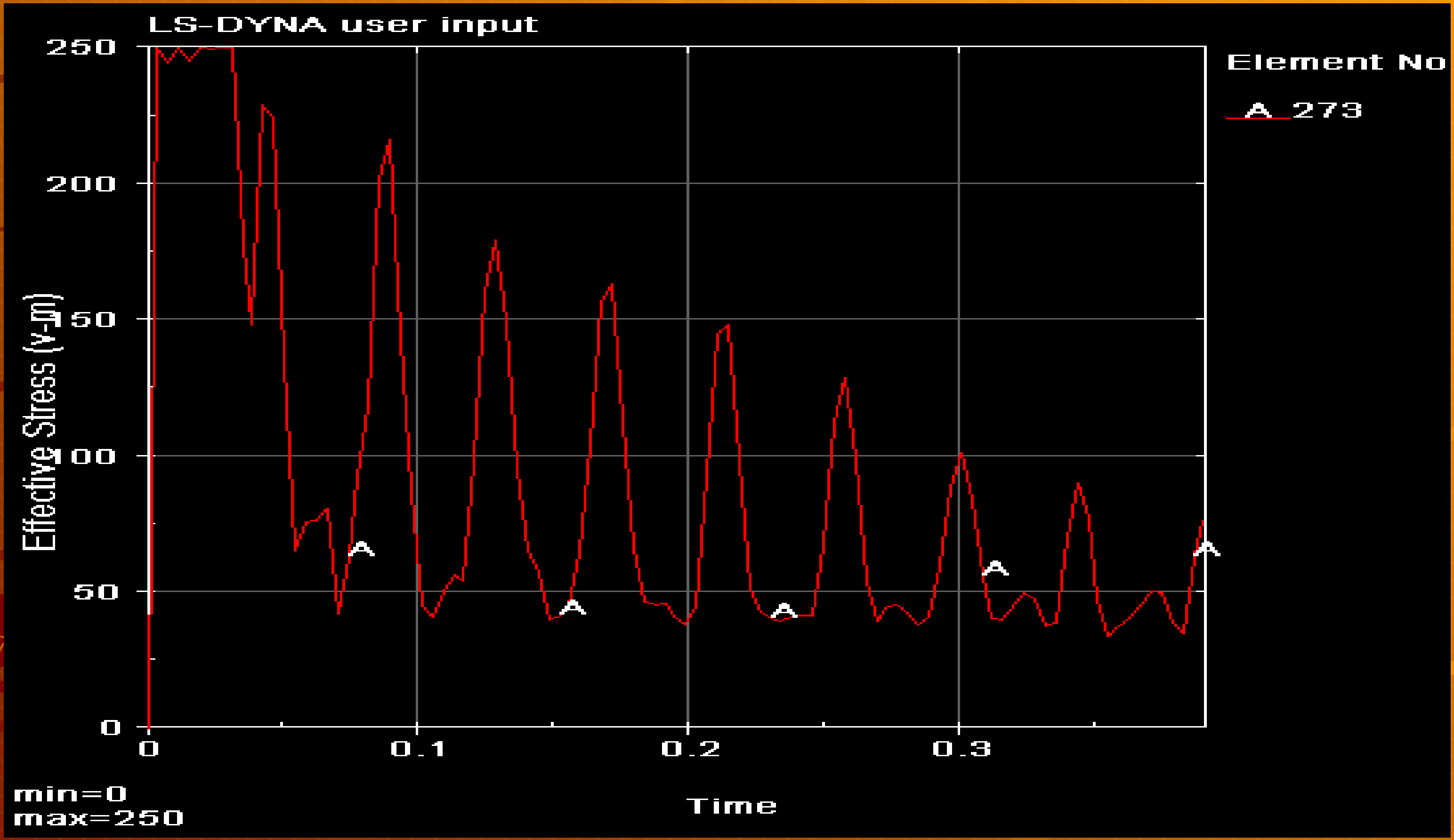
PLOT OF MAX.Z DISPLACEMENT VS TIME



AT THE MID LOADING POINT (NODE 67/ELEMENT 273)

MATERIAL ASTMA36 (YS = 250 N/mm^2)

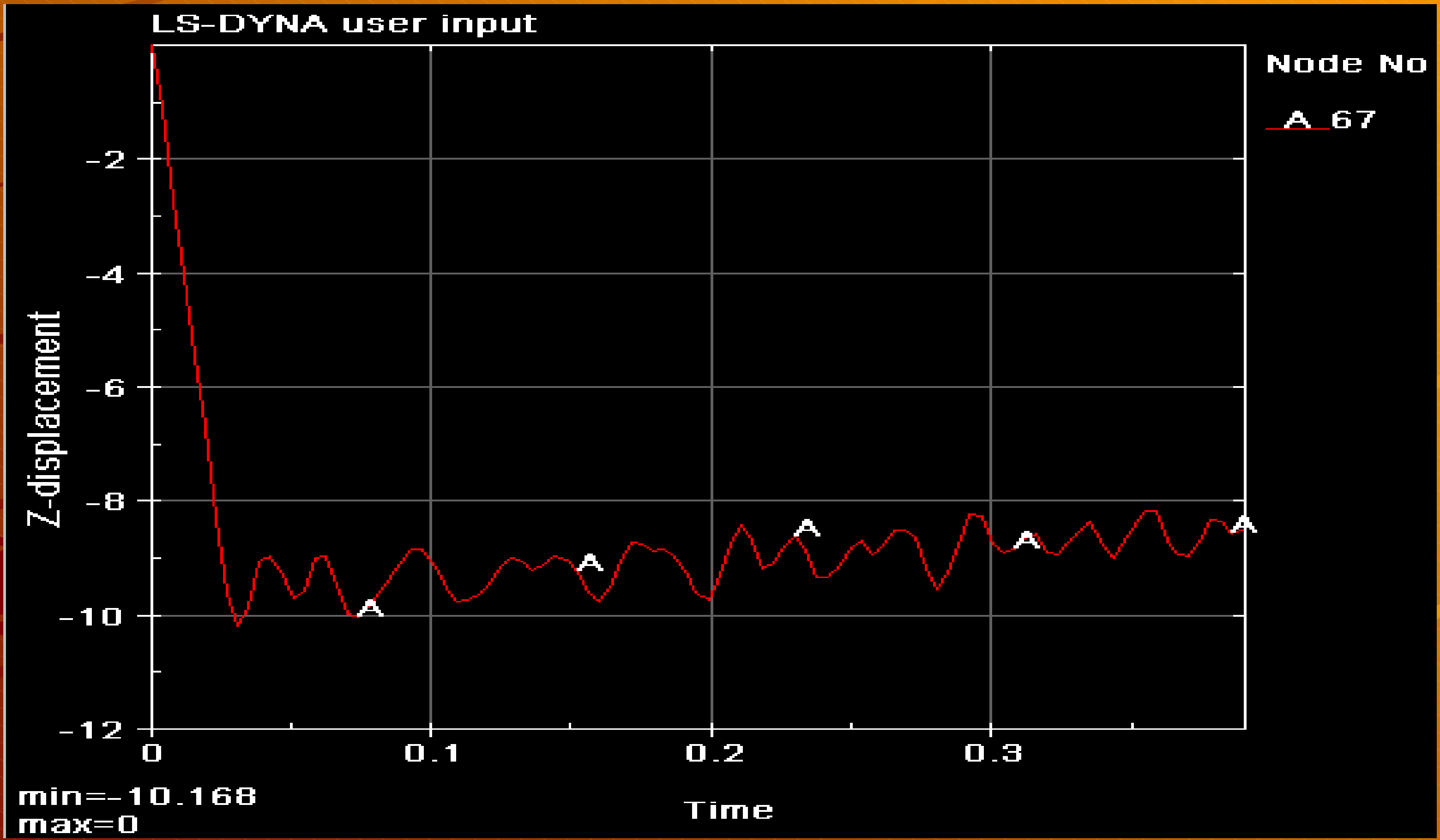
PLOT OF MAX EFFECTIVE STRESS VS TIME



THE MAX.OBSERVED STRESS VALUE = 250 N/mm^2 = (YIELD STRESS OF ASTMA36 → 250 N/mm^2)

MATERIAL WITH YS = 500 N/mm^2

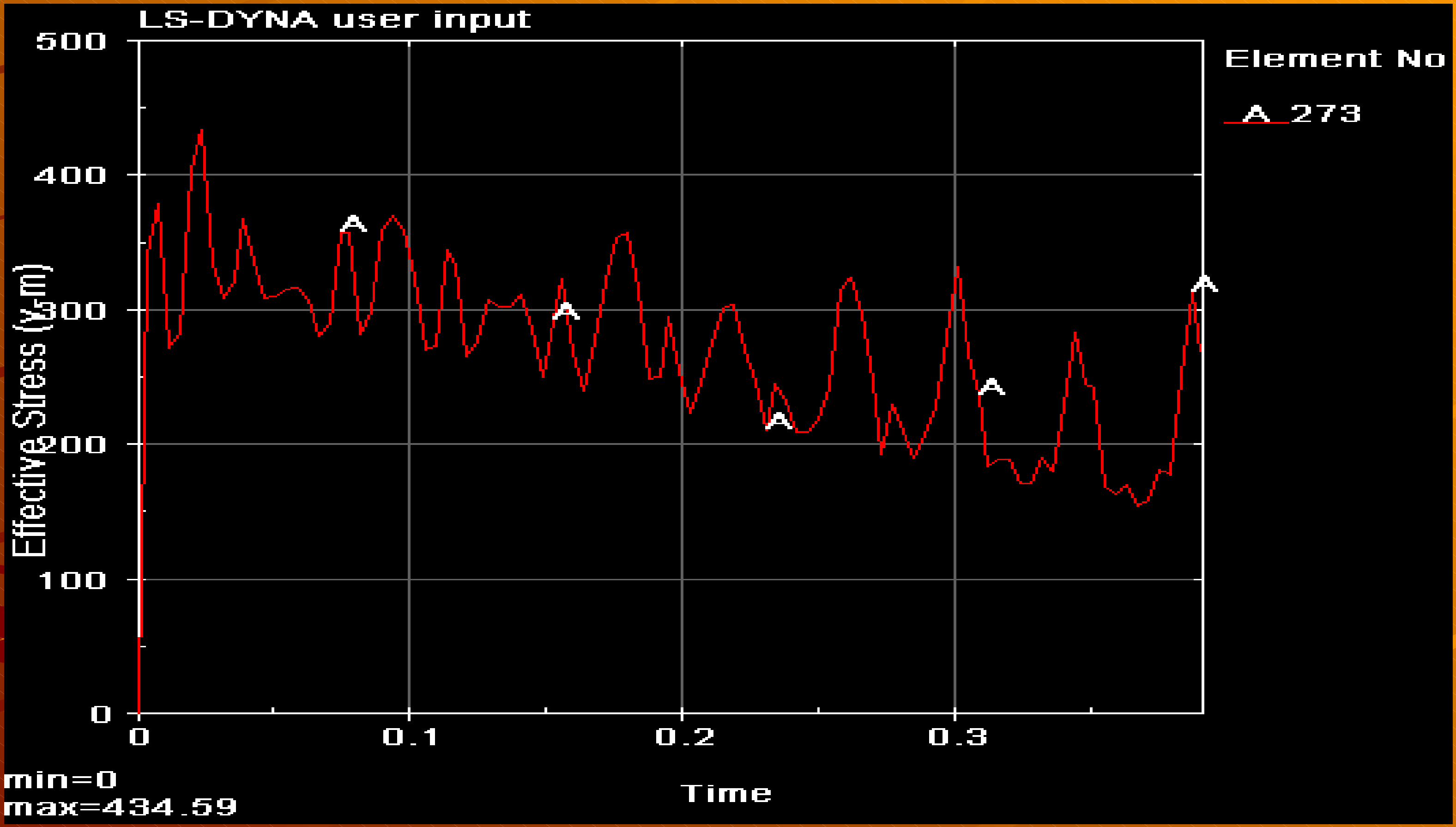
PLOT OF MAX.Z DISPLACEMENT VS TIME



AT THE MID LOADING POINT (NODE 67/ELEMENT 273)

MATERIAL WITH YS = 500 N/mm^2

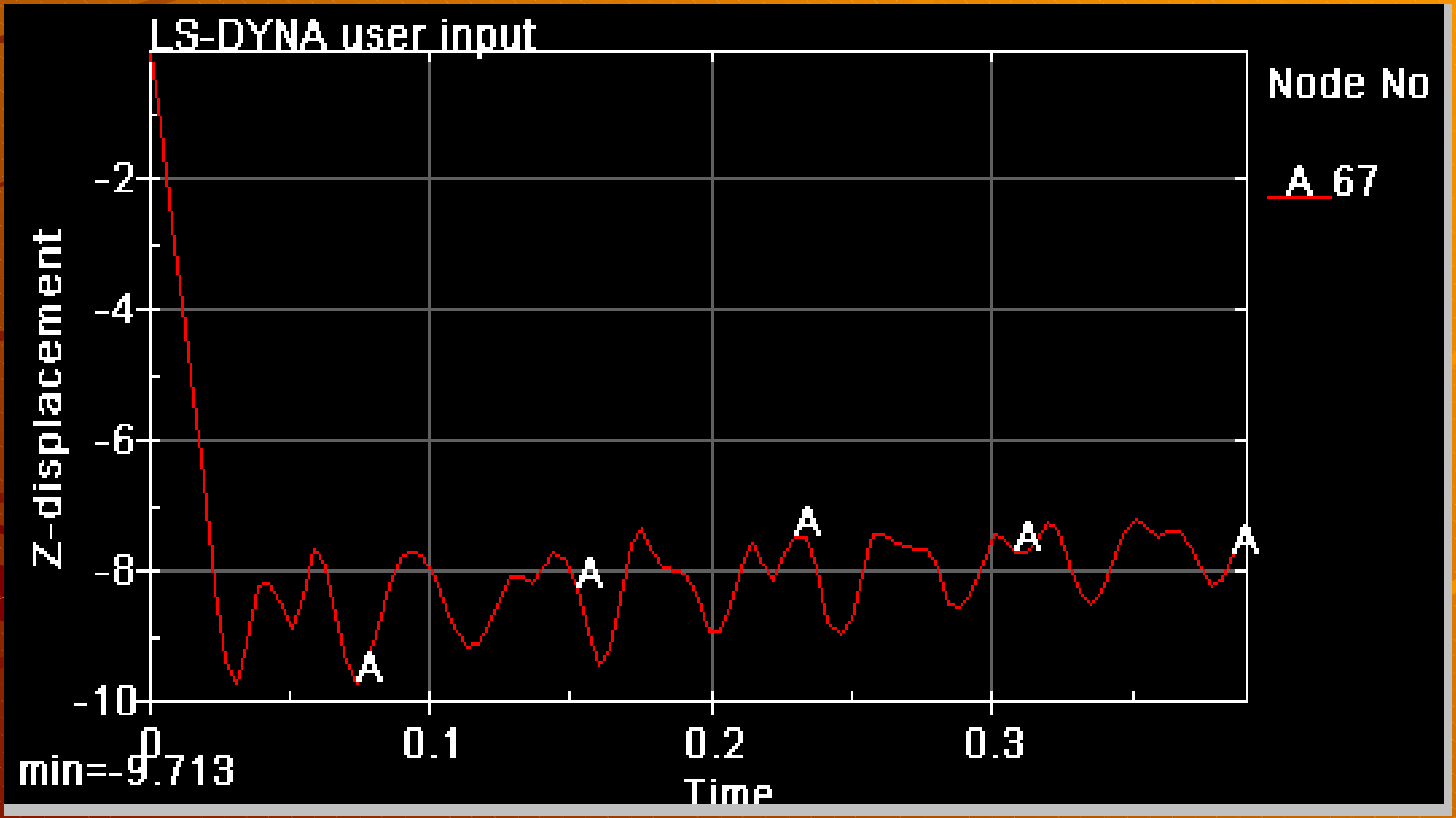
PLOT OF MAX EFFECTIVE STRESS VS TIME



THE MAX.OBSERVED STRESS VALUE = 435 N/mm^2 < (YIELD STRESS = 500 N/mm^2)

MATERIAL WITH YS = 600 N/mm^2

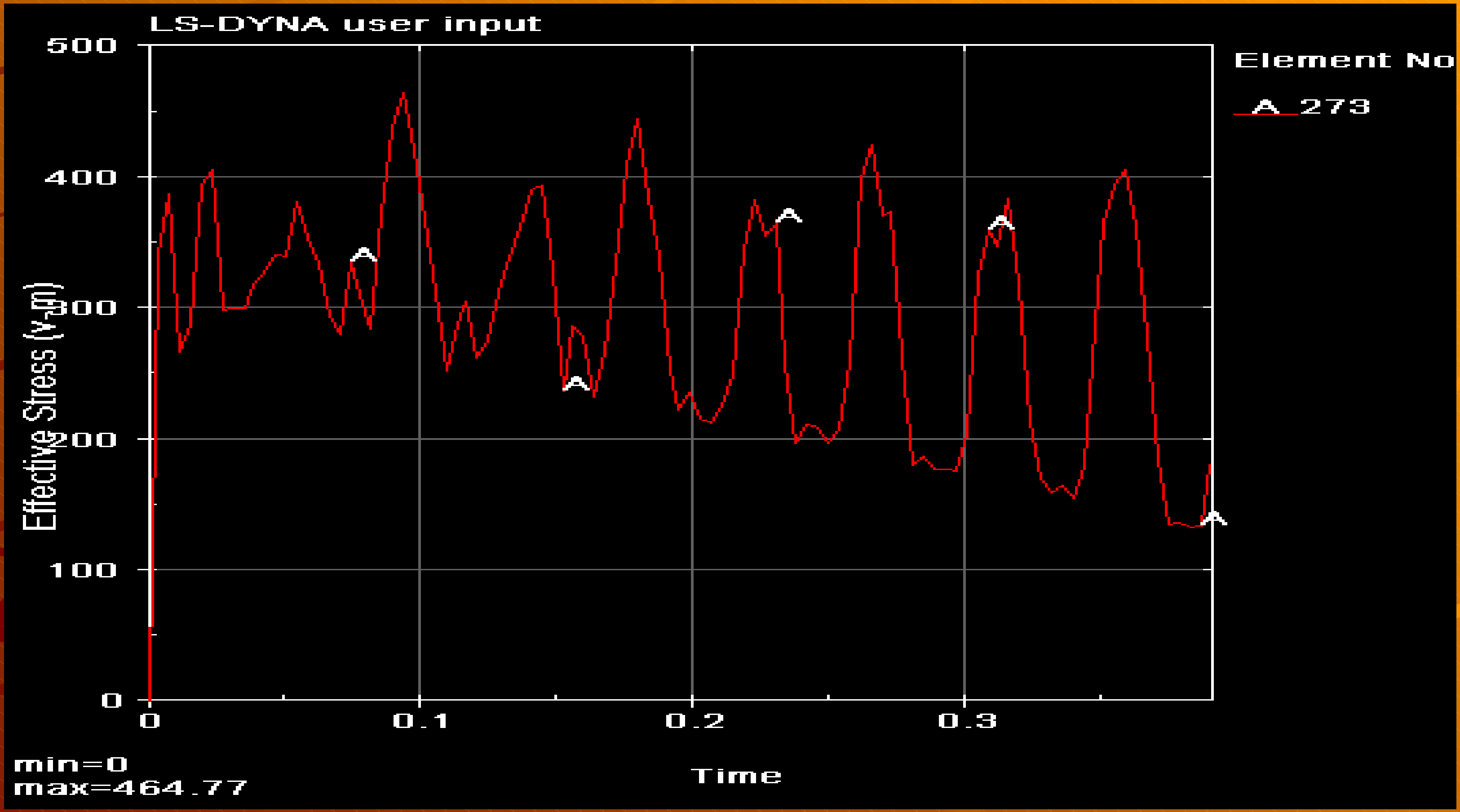
PLOT OF MAX.Z DISPLACEMENT VS TIME



AT THE MID LOADING POINT (NODE 67/ELEMENT 273)

MATERIAL WITH YS = 600 N/mm^2

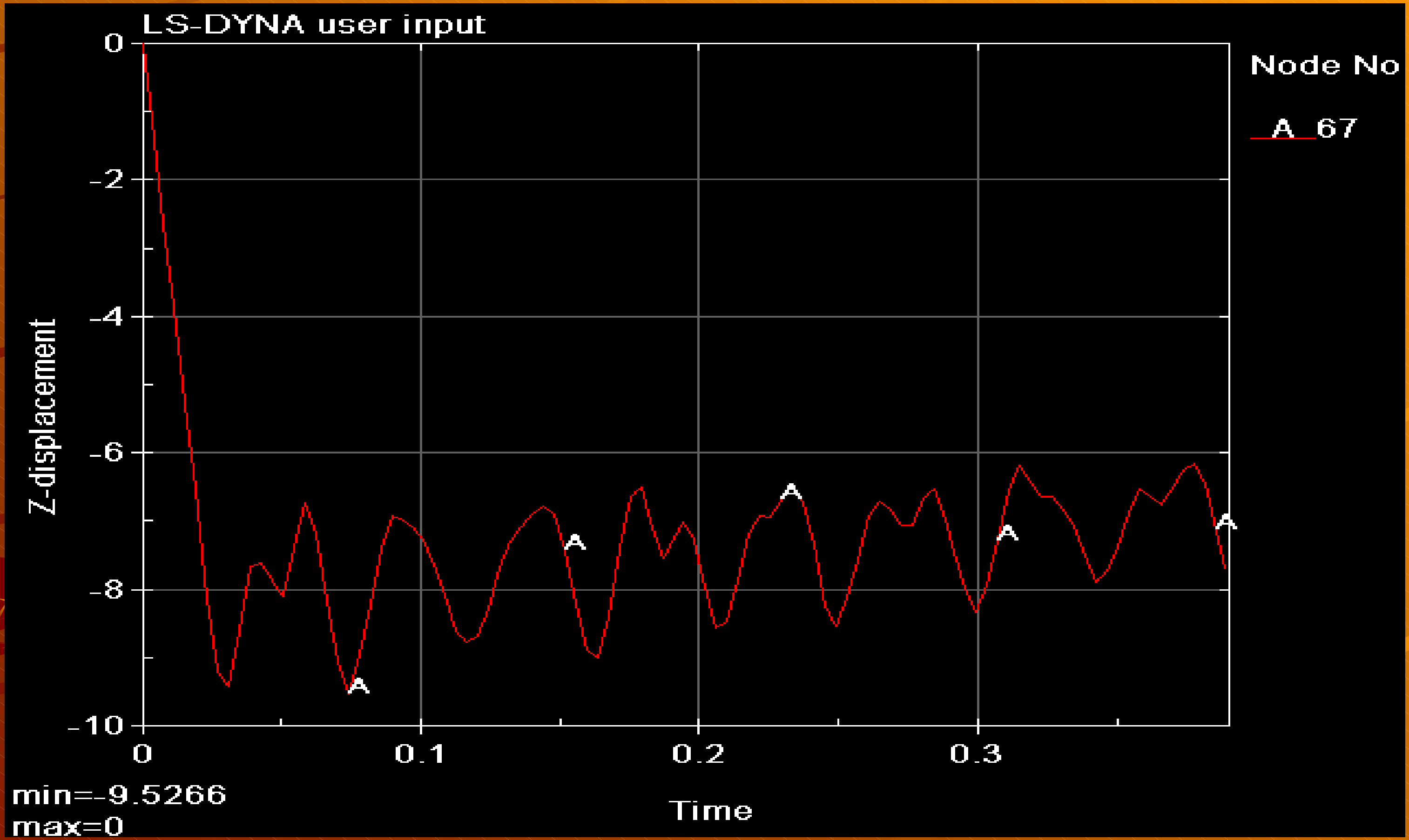
PLOT OF MAX EFFECTIVE STRESS VS TIME



THE MAX.OBSERVED STRESS VALUE = 465 N/mm^2 < (YIELD STRESS = 600 N/mm^2)

MATERIAL ASTMA709 (YS = 690 N/mm^2)

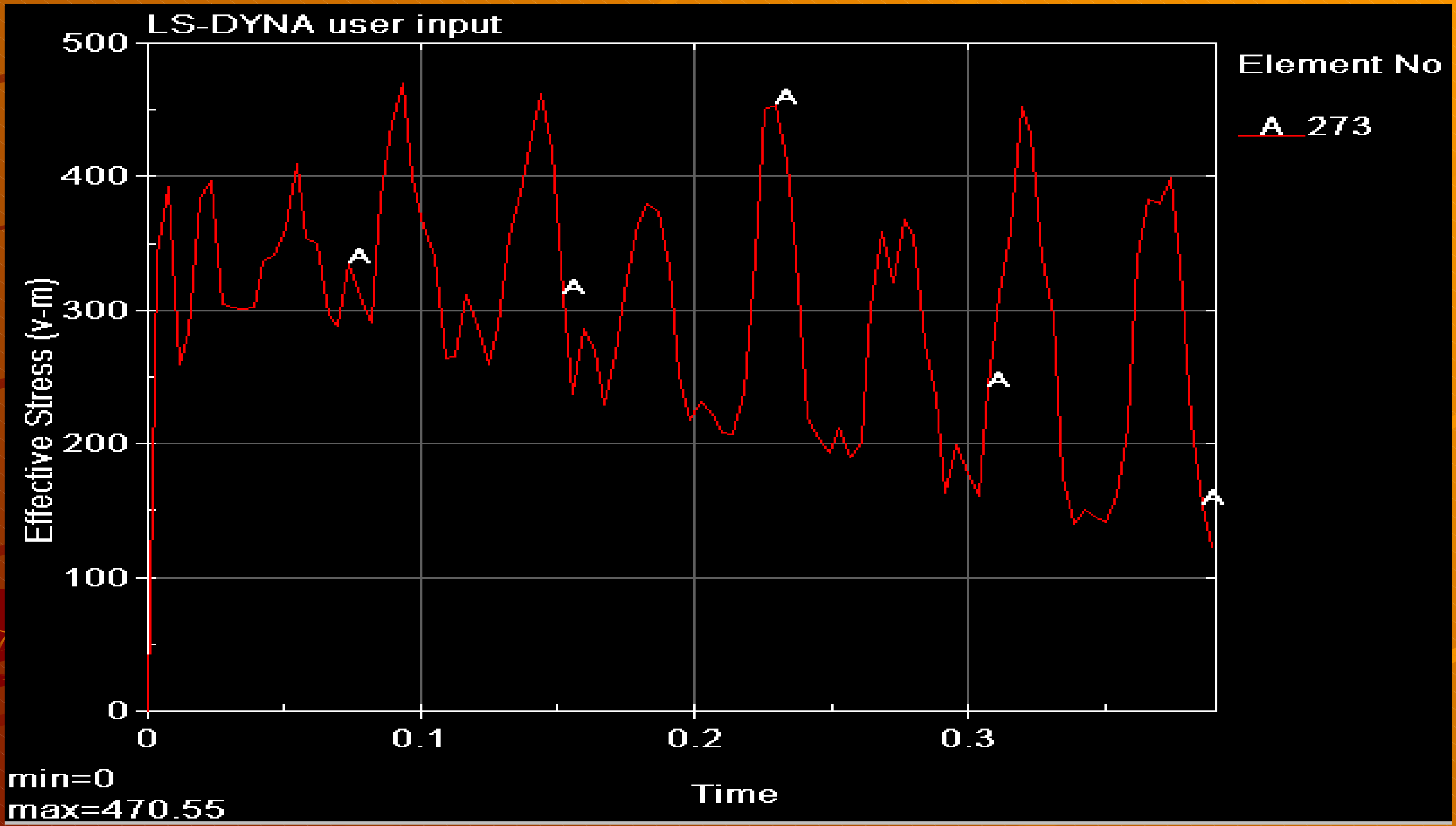
PLOT OF MAX.Z DISPLACEMENT VS TIME



AT THE MID LOADING POINT (NODE 67/ELEMENT 273)

MATERIAL ASTMA709 (YS = 690 N/mm^2)

PLOT OF MAX EFFECTIVE STRESS VS TIME



THE MAX.OBSERVED STRESS VALUE = 470 N/mm^2 < 690 N/mm^2 (YIELD STRESS OF ASTMA709 → 690 N/mm^2)

COMPARISON OF RESULTS

Yield strength of material taken for analysis (in N/mm2)	Max. value of z-deflection (mm) (Experimental)	Max. value of z-deflection (mm) (By analysis)	Remarks
250	9.72	15.247	62 % deviation
500	9.72	10.168	4.6% deviation
600	9.72	9.713	*< 0.1% deviation*
690	9.72	9.406	3.2% deviation

CONCLUSION

- The maximum deformation values obtained from the analysis do agree very well with the experimental values

- The material properties of the steel plate could be determined appropriately with the yield strength estimated to be 600 N/mm^2

WHAT NEXT ???

- Conduct a tensile test on the steel plate specimen
- Rerun the transient dynamic analysis with more accurate material properties.