RIGID-PLASTIC FINITE ELEMENT ANALYSIS OF FORGING PROCESS USING AFDEX

Amirah Nabilah binti Azman
Faculty of Mechanical Engineering
Universiti Teknologi MARA Shah Alam, Malaysia

No	Title
1	ABSTRACT
2	INTRODUCTION
3	AFDEX BACKGROUND
4	OBJECTIVES
5	METHODOLOGY
6	PRODUCT 1 – RIVET NUT
7	PRODUCT 2 – WHEEL LOCK NUT
8	PRODUCT 3 – FLAT COUNTERSUNK NUT BOLT
9	PRODUCT 4 – SOCKET CAP SCREW
10	CONCLUSION

Abstract

- Forging is a controlled plastic deformation process in which the work material is compressed between two dies using either impact or gradual pressure to form the part.
- Forging can be classified to hot forging, warm forging, and cold forging.
- CAD & CAM software, such as AUTOCAD and AFDEX can be used to design dies and simulate the forging process.
- For this project, there are 4 product chosen in which the process design for each of the product were refer from reference book.
- The process design were drawn using AutoCAD and the simulation was done using AFDEX, a metal forming simulator.
- Various parameter were obtained during the analysis such as effective stress, effective strain and flow line of each product.

Introduction

- Forging is the application of thermal and mechanical energy to steel billets or ingots to cause the material to change shape while in a solid state.

- The shape deformation is accomplished using hot, cold, or even warm forging processes.

- For this project, there are 4 chosen product is being analysed and the process chosen is cold forging process.

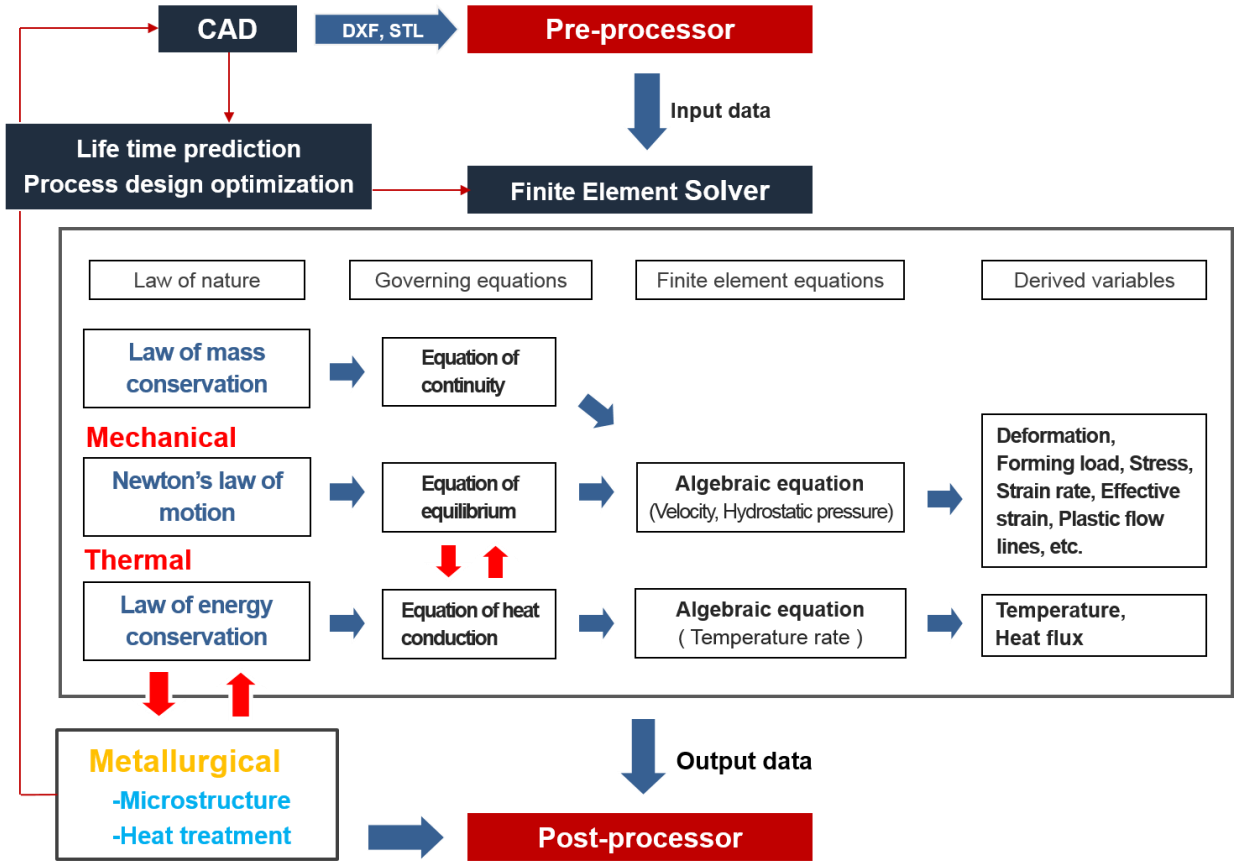
- Manufacturers may choose cold forging over hot forging for a number of reasons:
- Cold forged parts require very little or no finishing work
- Step of the fabrication process is often dispensable in which saves money
- Less susceptible to contamination problems
- Final component features a better overall surface finish

- AFDEX, a software in which theoretically based on the rigid- or elasto-thermoviscoplastic finite element method was used to analysis the product.

AFDEX Background

- AFDEX is an intelligent forging simulation that is describe as the forging simulation for higher accuracy with minimized user intervention.

Overview of AFDEX



AFDEX 2D and AFDEX 3D

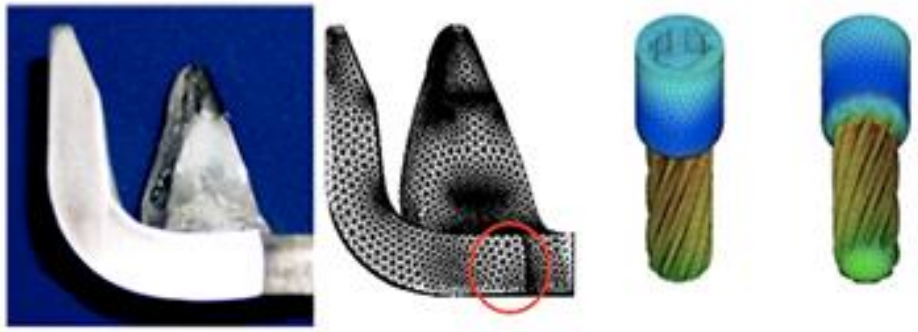
Item	AFDEX 2D	AFDEX 3D
Nimerical method	Rigid/Elasto-Thermoviscoplastic Finite Element Method	
Finite element	Quadrilateral element, Conventional FEM	Tetrahedral element, MINI-element FEM, Hexahedral element
Incompressibility condition	Penalty method, Lagrange multiplier method	Lagrange multiplier method
Linear equation	Direct method	Iterative method, Direct method
CAD I/F	DXF file	STL file
Friction	Coulomb friction law, constant shear friction law, Hybrid friction law, use friction model	

Objectives

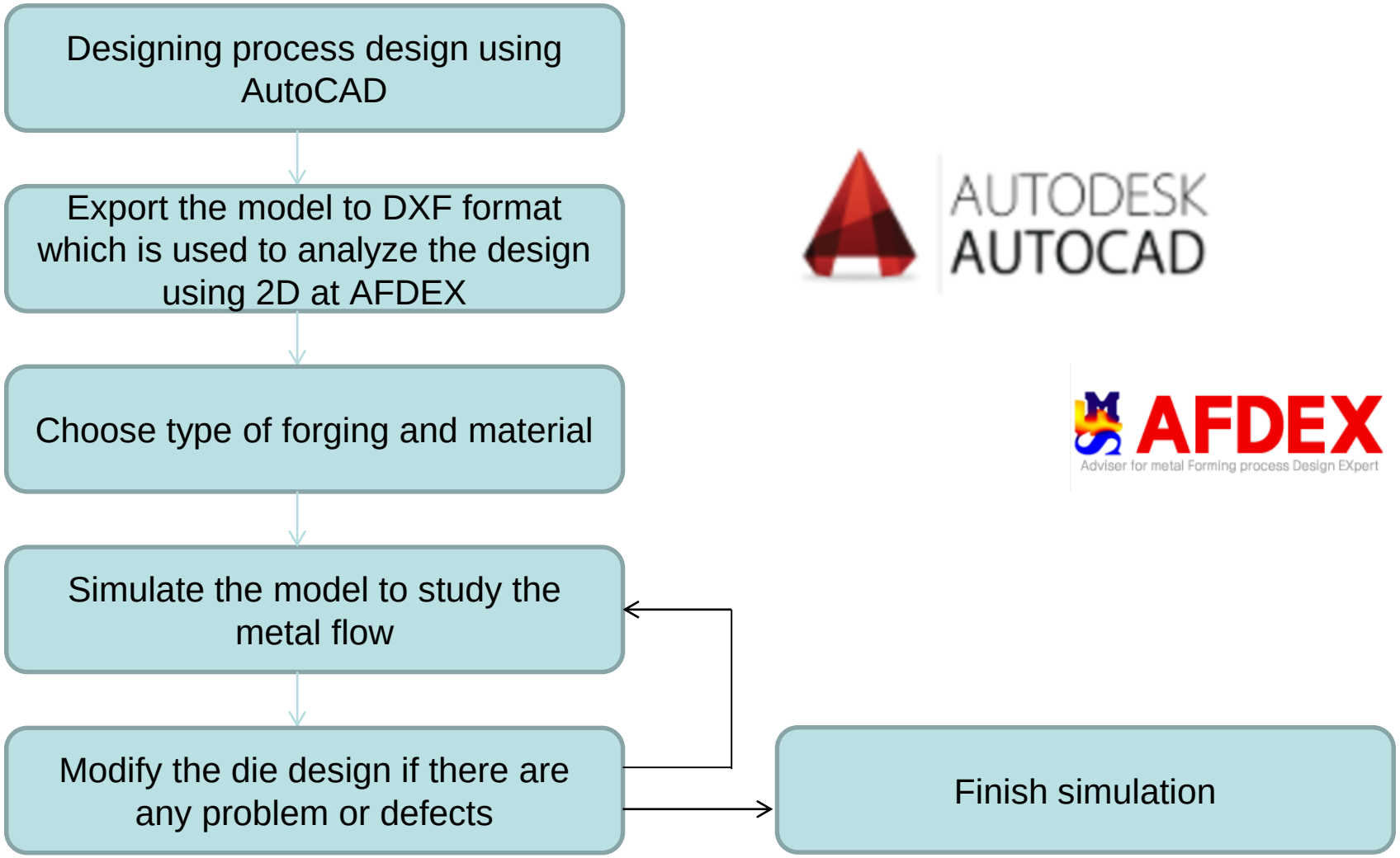
1. To analyse the simulation of cold forging process of products by using AFDEX.

2. To demonstrate the ability of AFDEX as a metal forming simulator.

3. To determine the design of die used in cold forging process of the products using AutoCAD software.



Methodology

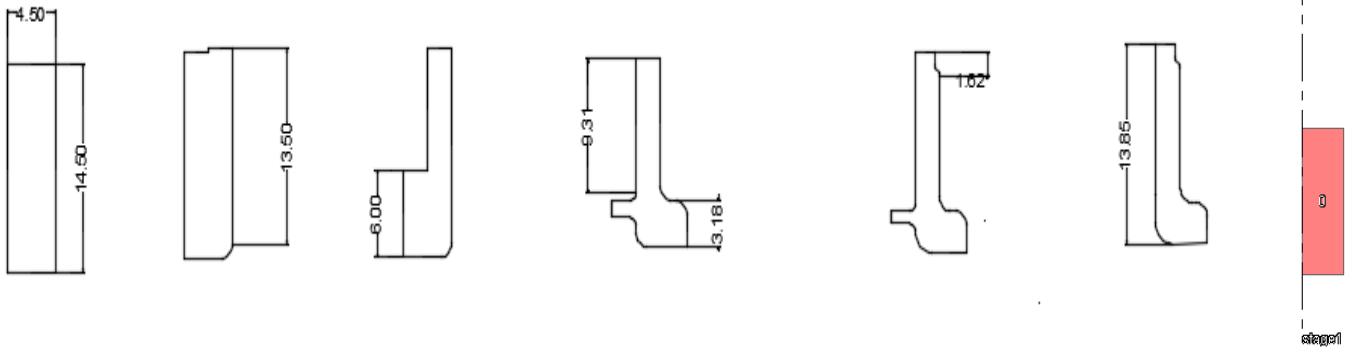


AUTODESK AUTOCAD

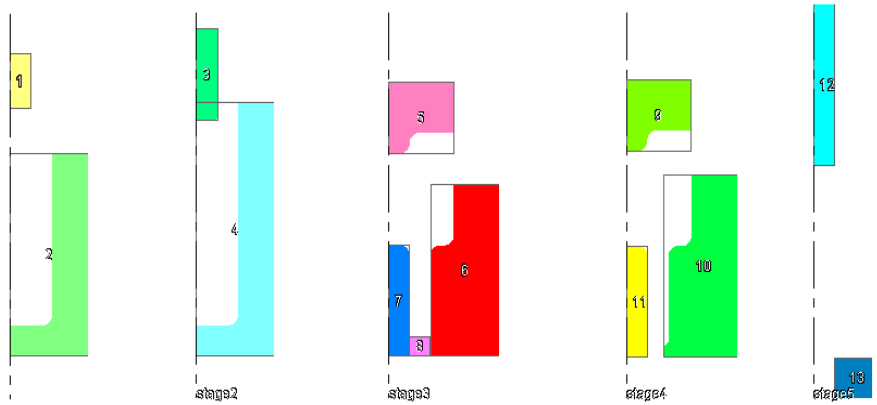
AFDEX
Adviser for metal Forming process Design EXpert

Product 1 - Rivet Nut

PROCESS DESIGN



DIE DESIGN

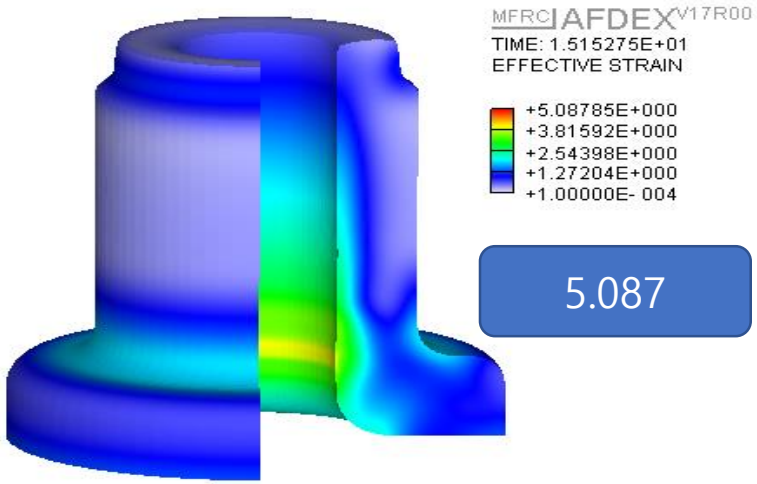


PROCESS DESCRIPTION

INFORMATION ABOUT MATERIAL	INFORMATION ABOUT DIE
AISI1010 (T=20ºC)	Friction : : Soap_Cold(Steel)
Dimension : 4.5 x 14.5 mm	Die velocity : Constant (Upper die : -1.0 mm/s, Lower die : 0.0 mm/s
Initial temperature : Room temperature	

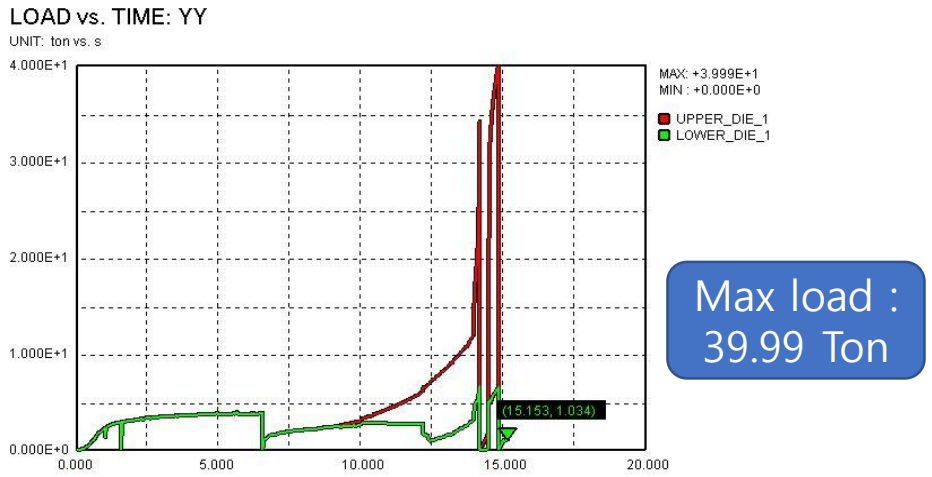
Product 1 - Rivet Nut - Results

EFFECTIVE STRAIN



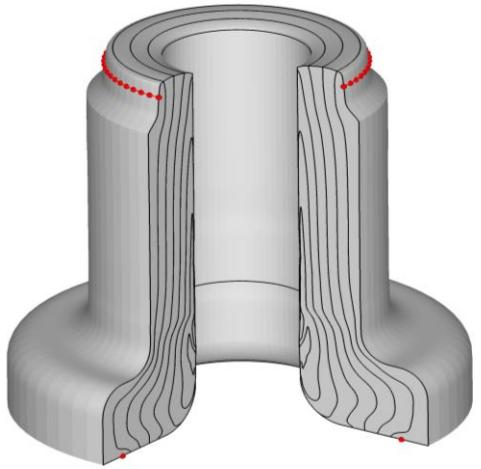
5.087

LOAD VS TIME : YY

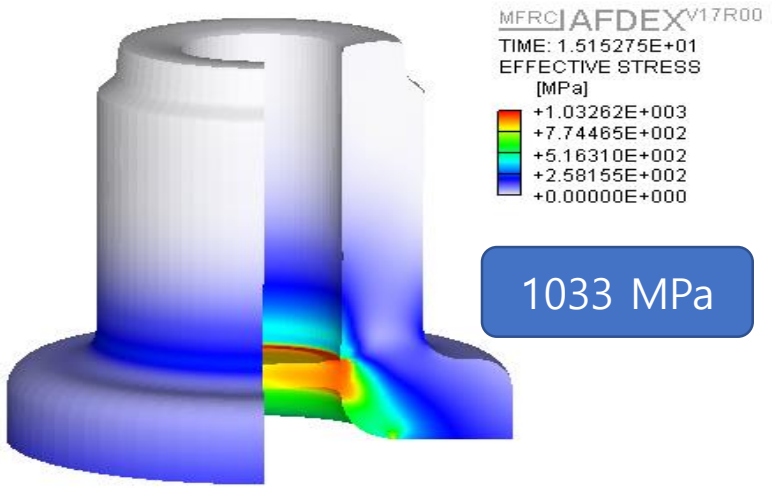


Max load : 39.99 Ton

FLOWLINE

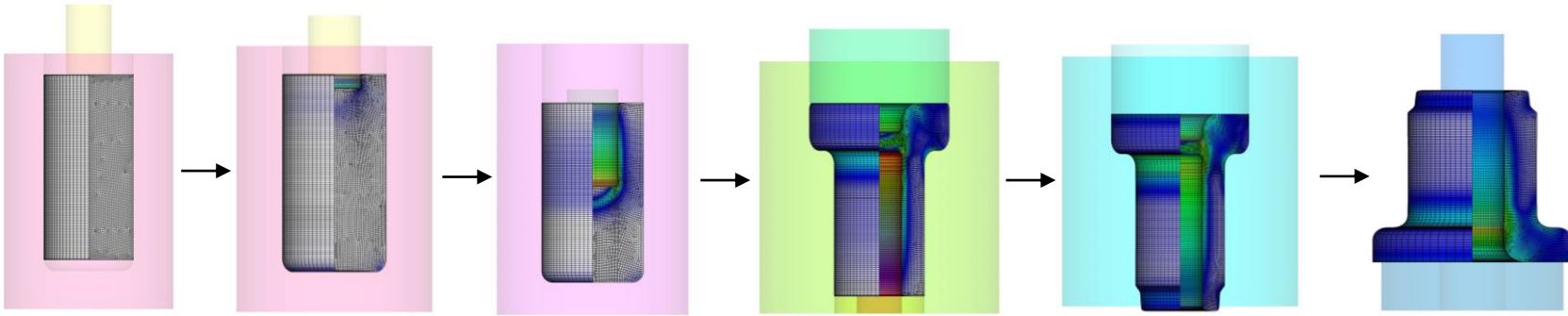


EFFECTIVE STRESS



1033 MPa

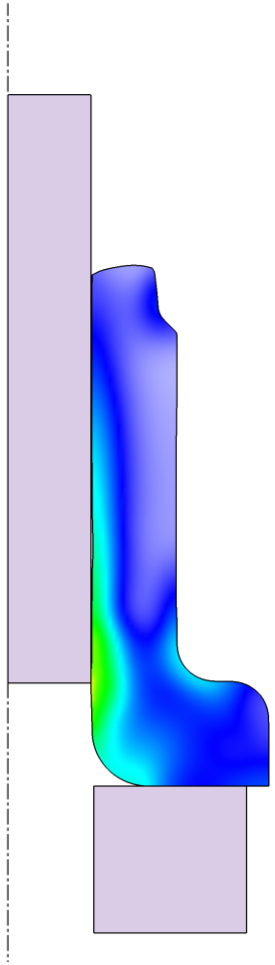
STAGES – 3D VIEW



Initial | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5

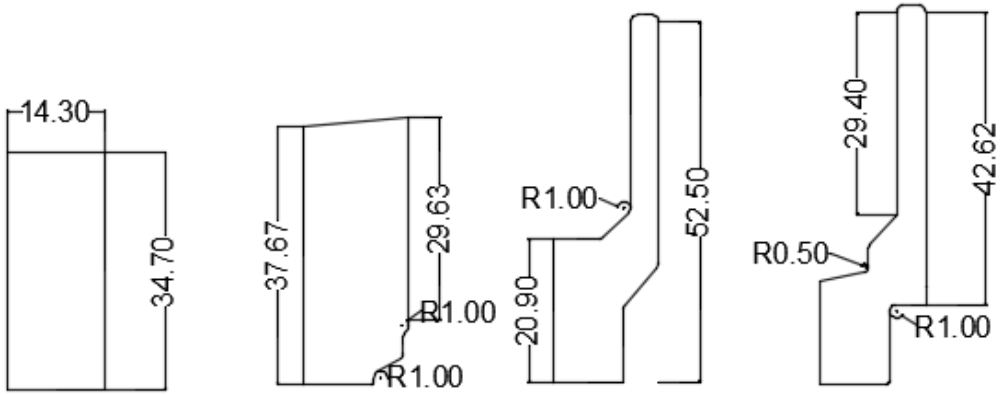
Product 1 - Rivet Nut - Simulation

MFRC AFDEX V17R00

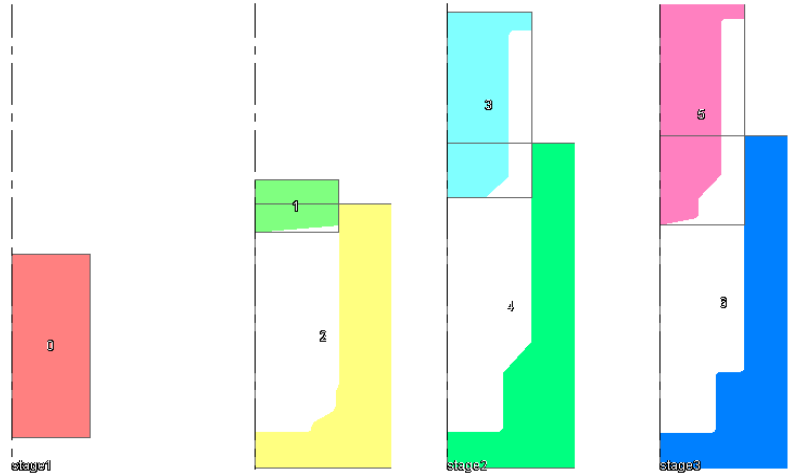


Product 2 - Wheel Lock Nut

PROCESS DESIGN



DIE DESIGN

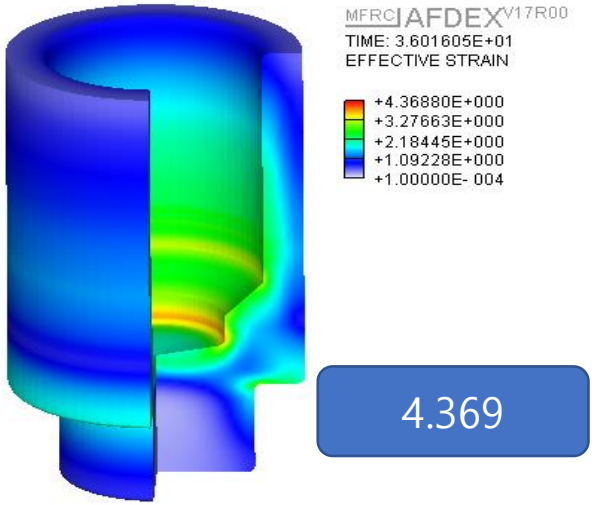


PROCESS DESCRIPTION

INFORMATION ABOUT MATERIAL	INFORMATION ABOUT DIE
AISI1010 (T=20°C)	Friction : : Soap_Cold(Steel)
Dimension : 14.3 x 34.7 mm	Die velocity : Constant (Upper die : -1.0 mm/s, Lower die : 0.0 mm/s
Initial temperature : Room temperature	

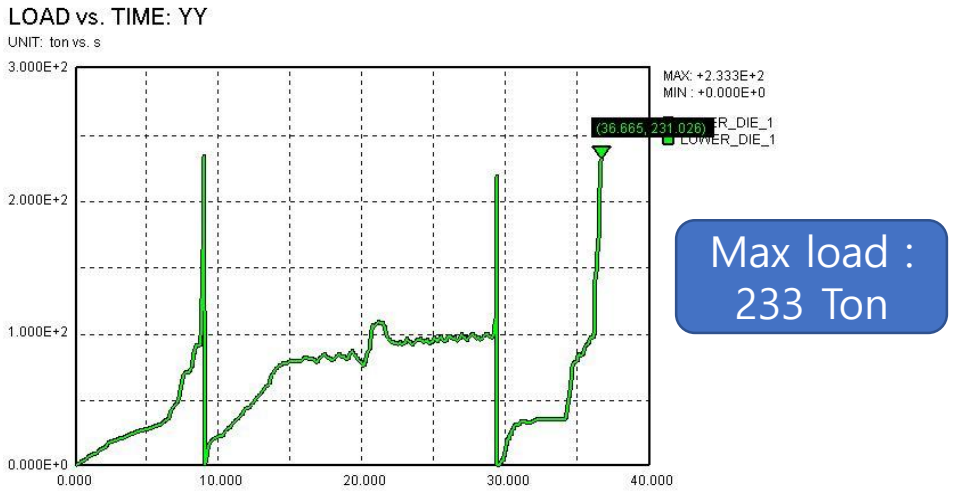
Product 2 - Wheel Lock Nut - Results

EFFECTIVE STRAIN



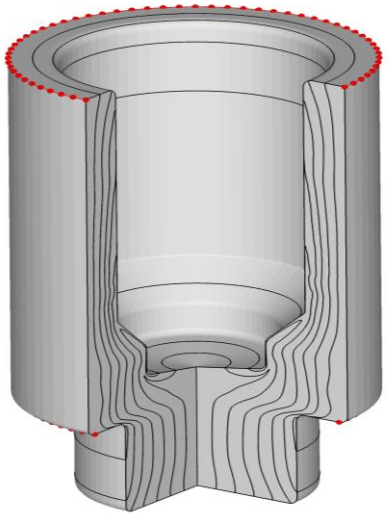
4.369

LOAD VS TIME : YY

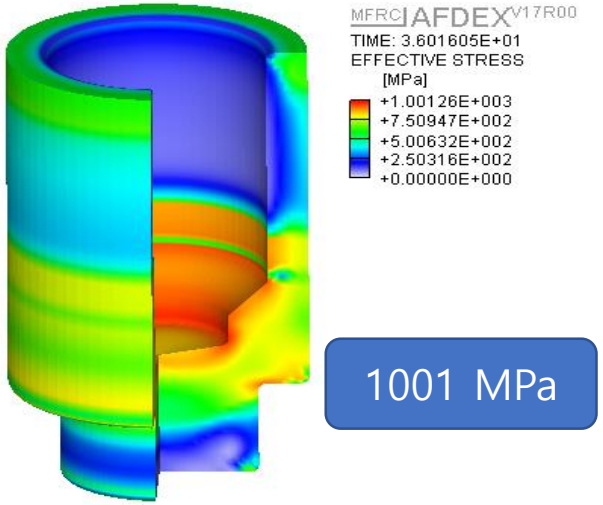


Max load : 233 Ton

FLOWLINE

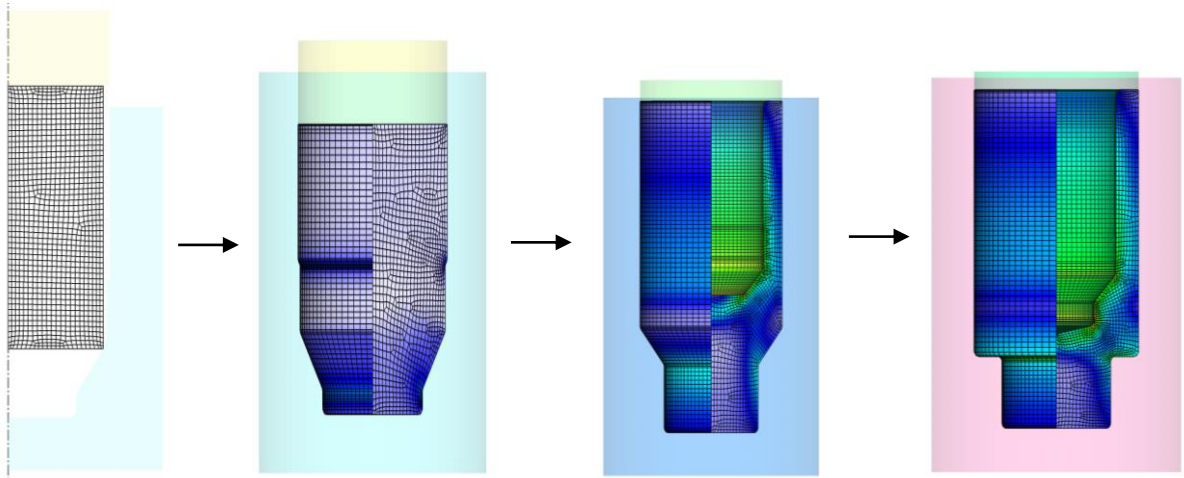


EFFECTIVE STRESS



1001 MPa

STAGES – 3D VIEW



Initial | Stage 1 | Stage 2 | Stage 3

Product 2 - Wheel Lock Nut - Simulation

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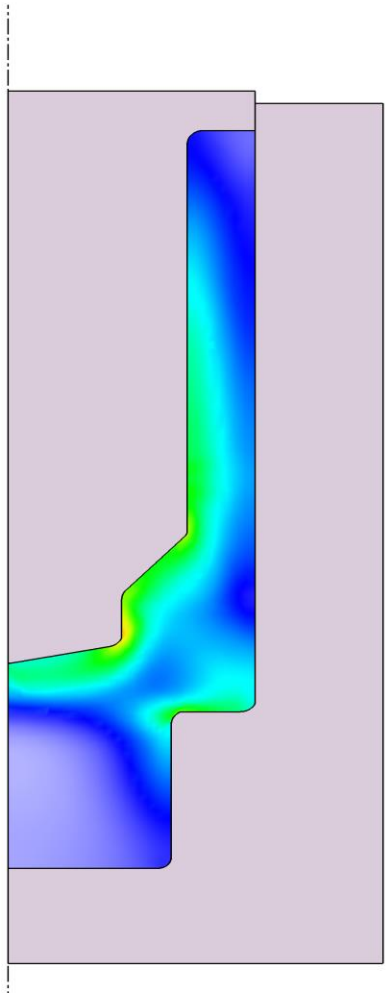
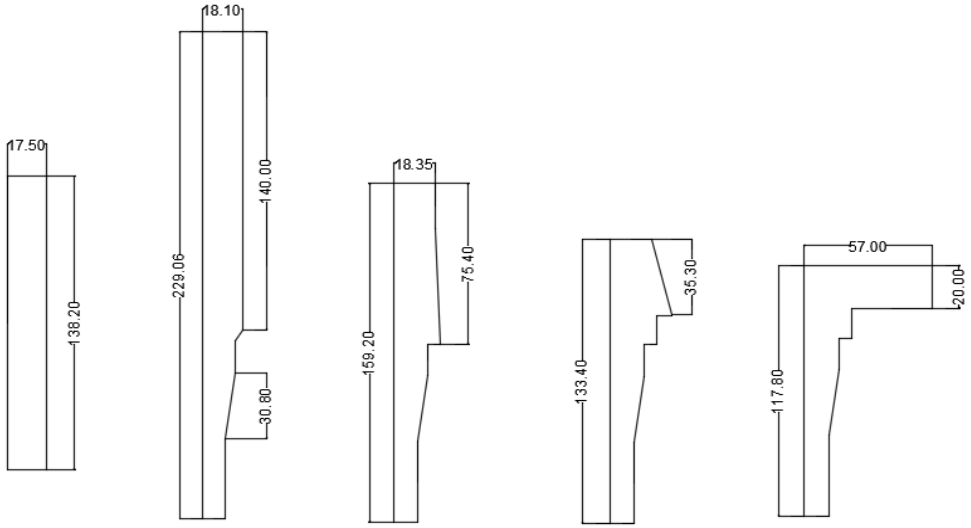
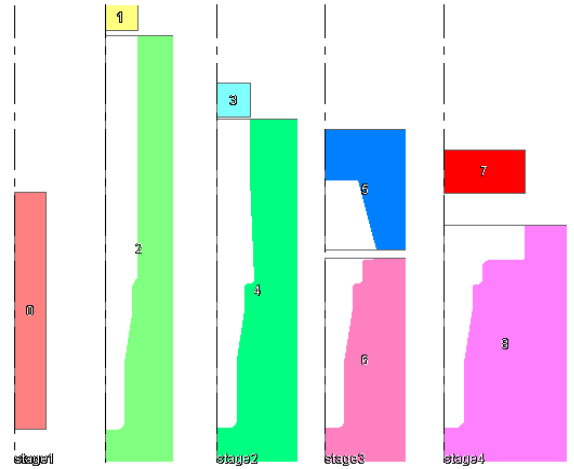


Product 3 - Flat Countersunk Nut Bolt

PROCESS DESIGN



DIE DESIGN

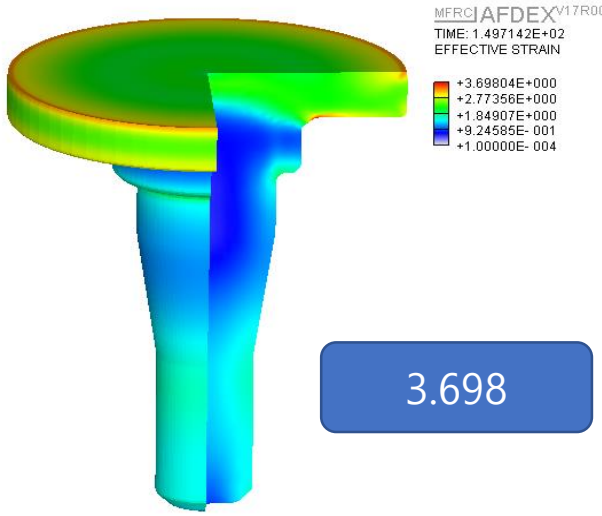


PROCESS DESCRIPTION

INFORMATION ABOUT MATERIAL	INFORMATION ABOUT DIE
AISI1010 (T=20°C)	Friction : : Soap_Cold(Steel)
Dimension : 17.5 x 138.2 mm	Die velocity : Constant (Upper die : -1.0 mm/s, Lower die : 0.0 mm/s
Initial temperature : Room temperature	

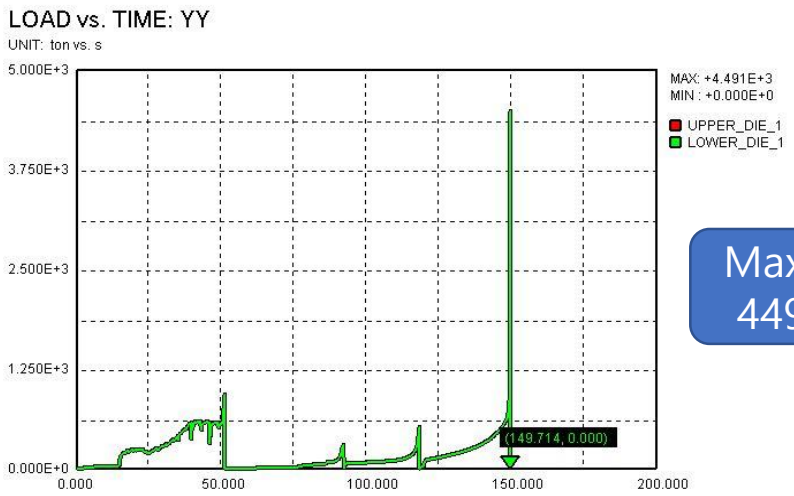
Product 3 - Flat Countersunk Nut Bolt - Results

EFFECTIVE STRAIN



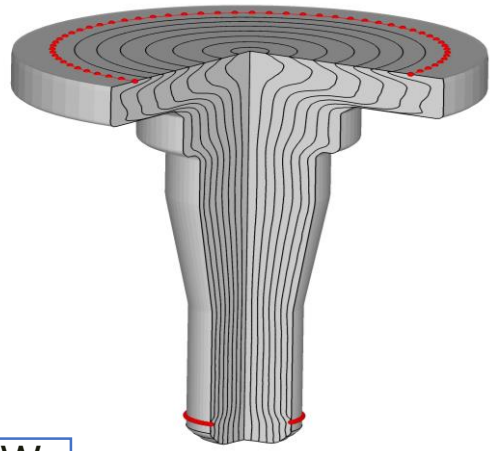
3.698

LOAD VS TIME : YY

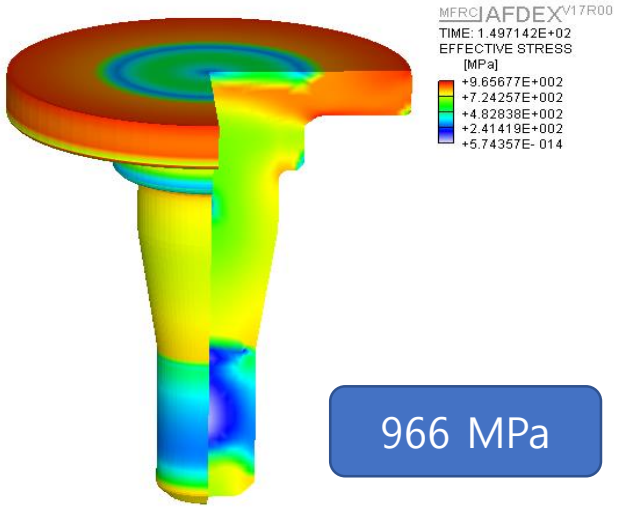


Max load : 4491 Ton

FLOWLINE

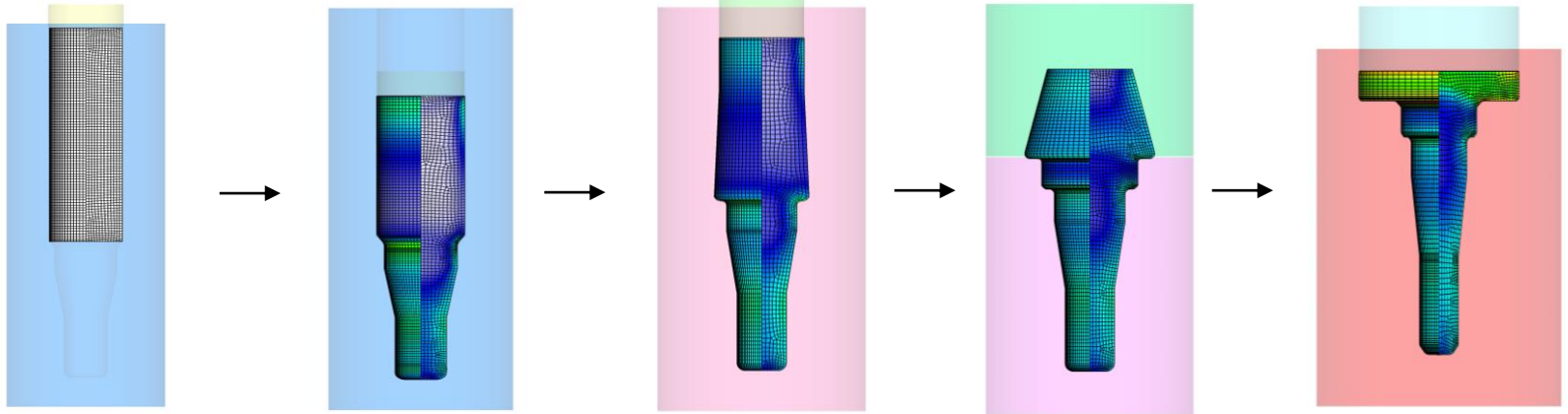


EFFECTIVE STRESS



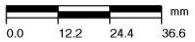
966 MPa

STAGES – 3D VIEW



Initial | Stage 1 | Stage 2 | Stage 3 | Stage 4

Product 3-Flat Countersunk Nut Bolt-Simulation



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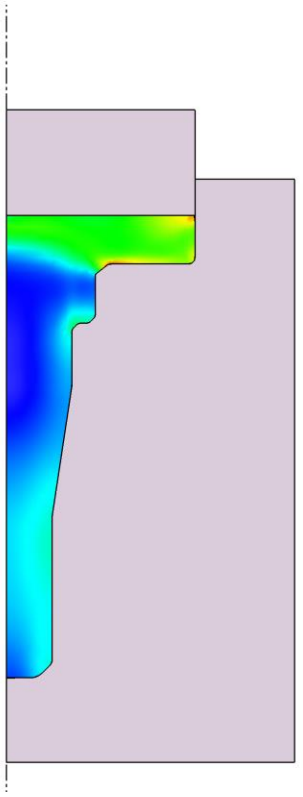
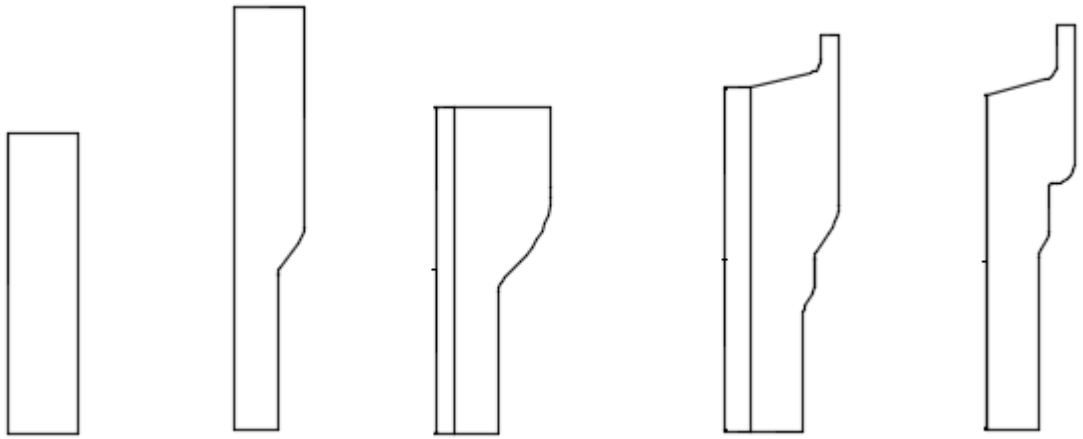
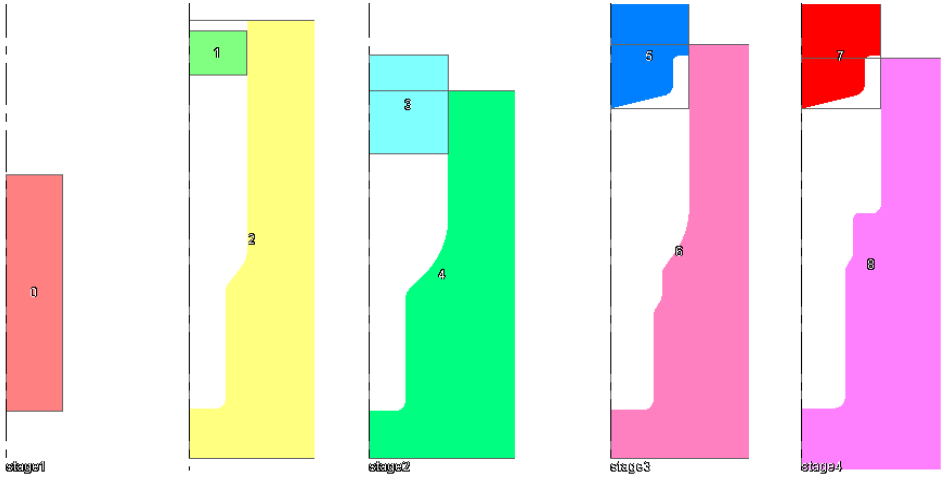


Product 4 - Socket Cap screw

PROCESS DESIGN



DIE DESIGN

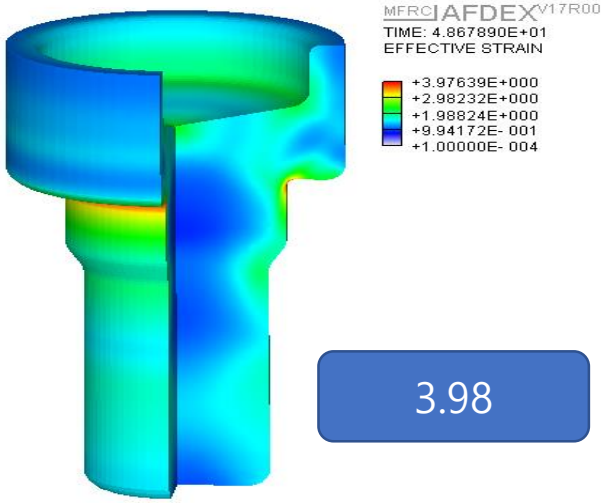


PROCESS DESCRIPTION

INFORMATION ABOUT MATERIAL	INFORMATION ABOUT DIE
AISI1010 (T=20°C)	Friction : : Soap_Cold(Steel)
Dimension : 10.6 x 43.18 mm	Die velocity : Constant (Upper die : -1.0 mm/s, Lower die : 0.0 mm/s
Initial temperature : Room temperature	

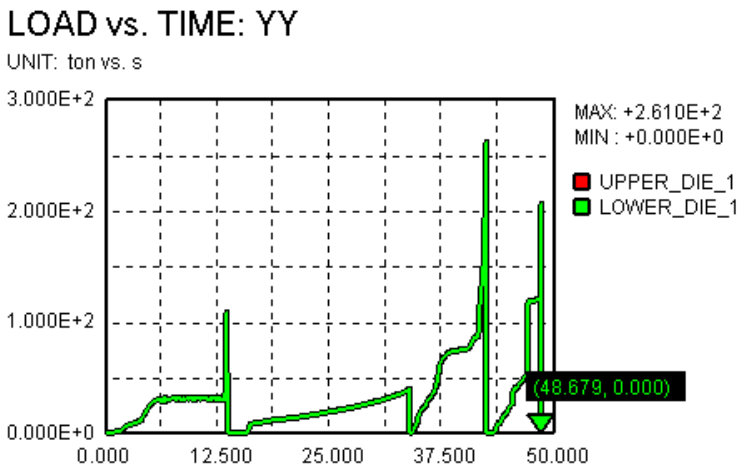
Product 4 - Socket Cap screw - Results

EFFECTIVE STRAIN



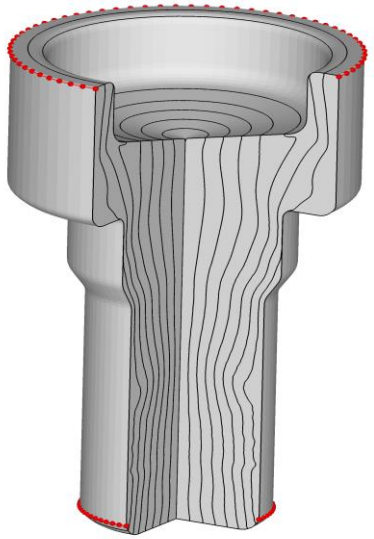
3.98

LOAD VS TIME : YY

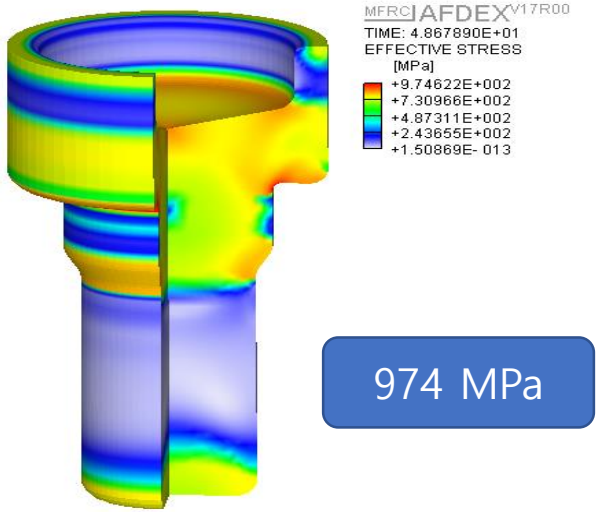


Max load : 261 Ton

FLOWLINE

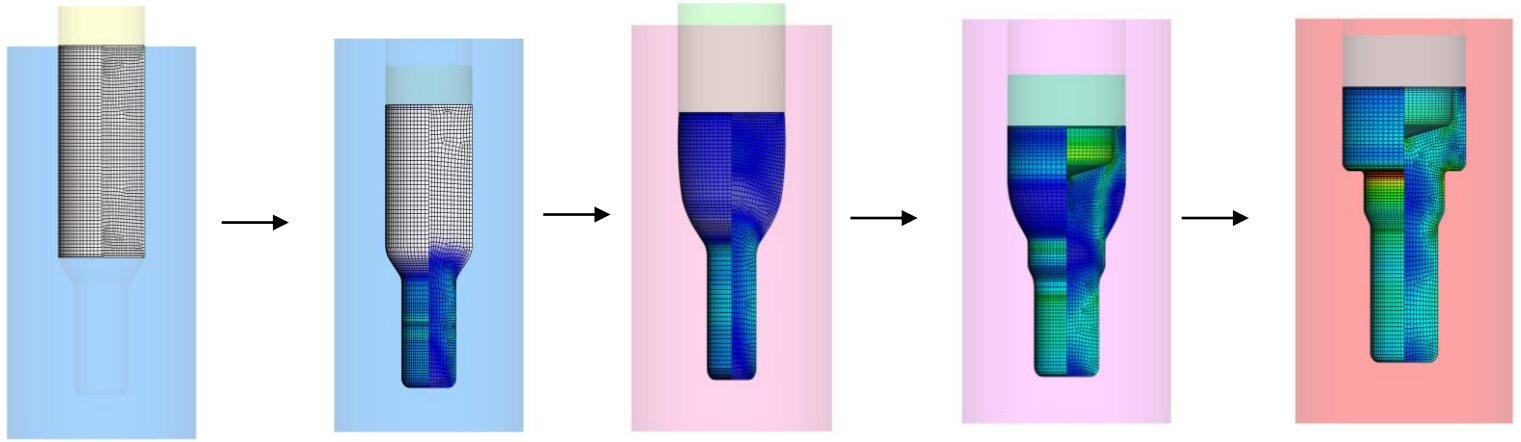


EFFECTIVE STRESS



974 MPa

STAGES – 3D VIEW



Initial | Stage 1 | Stage 2 | Stage 3 | Stage 4

Product 4 - Socket Cap screw – Simulation

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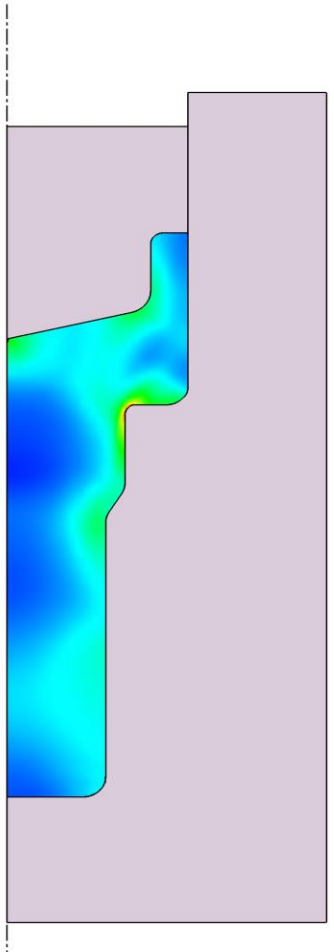

Conclusion

- All important parameters which are effective stress, effective strain, load and flow line for each product managed to be obtain.
- The applicable die design were managed to be designed for each of the product.
- Cold forging process for each product were able to be analysed throughout the simulation.