SIMULATION OF FLOW DRILL SCREWING.

THERMO-MECHANICAL ANALYSIS USING COUPLED EULERIAN-LAGRANGIAN ELEMENT FORMULATION.

Production System | 05 Dec 2018
Jonas Zweck ; Thomas Richter

BMW GROUP

THE NEXT 100 YEARS

AGENDA.

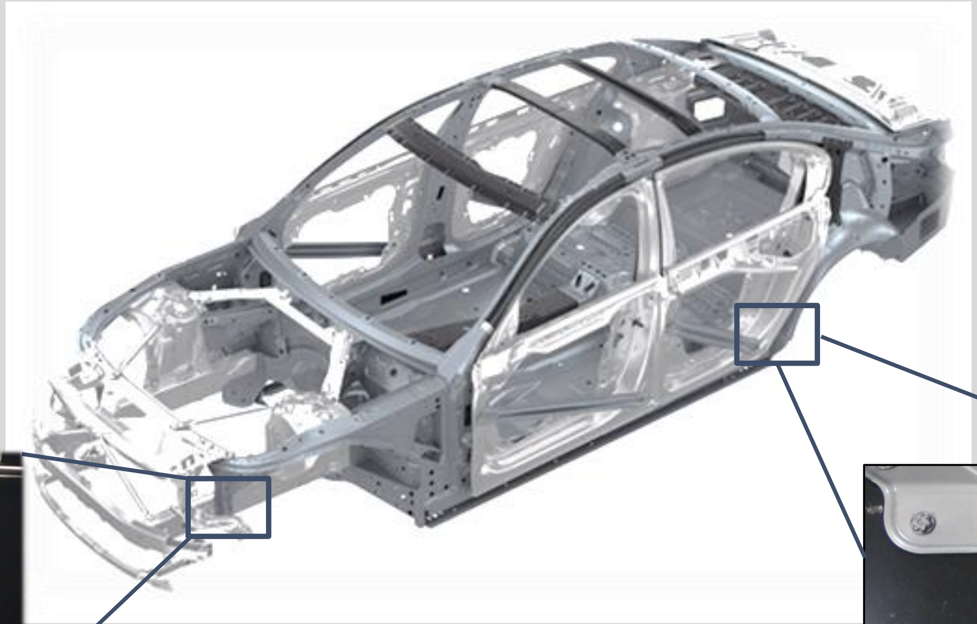
- Motivation.
- Basics of Flow Drill Screwing Process.
- Simulation Modell.
- Comparison with an adaptive Velocity Flowdrill Process.
- Simulation Results: Screw Geometries.
- Summary.

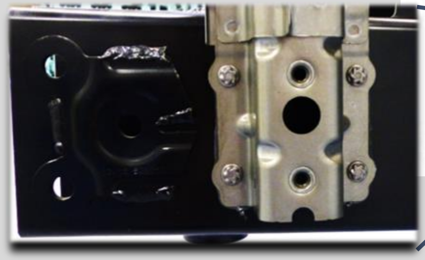
MOTIVATION.

REDUCE CO2 EMISSIONS.

Reduce weight

Aluminium Wrought and Aluminium Casts





INCREASE USER EXPERIENCE.

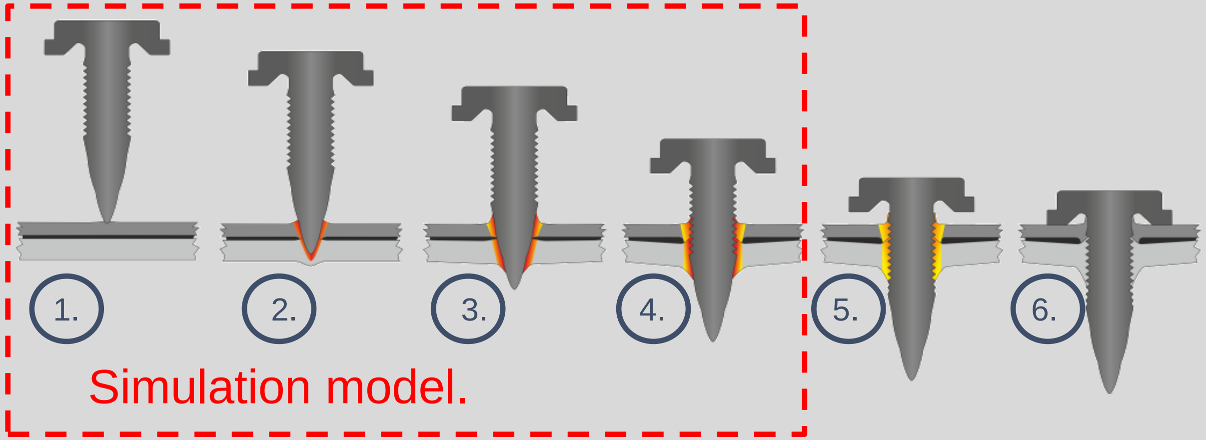
Increase Comfort and Safety

High Strength steels

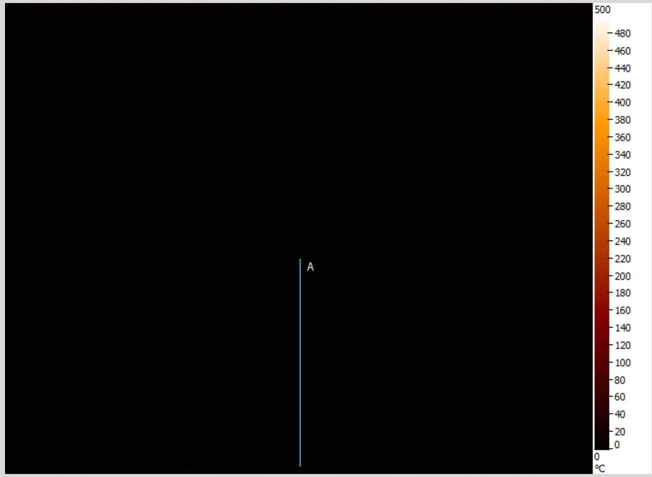
Use of Simulation to identify Potentials to develop new Process limits without intensive prototyping.

BASICS OF FLOW DRILL SCREWING PROCESS.

- Screw Positioning.
- Heat Generation and whole forming.
- Whole Forming.
- Thread Forming.
- Screw in.
- Fastening.



Flow Drill Screw Process.



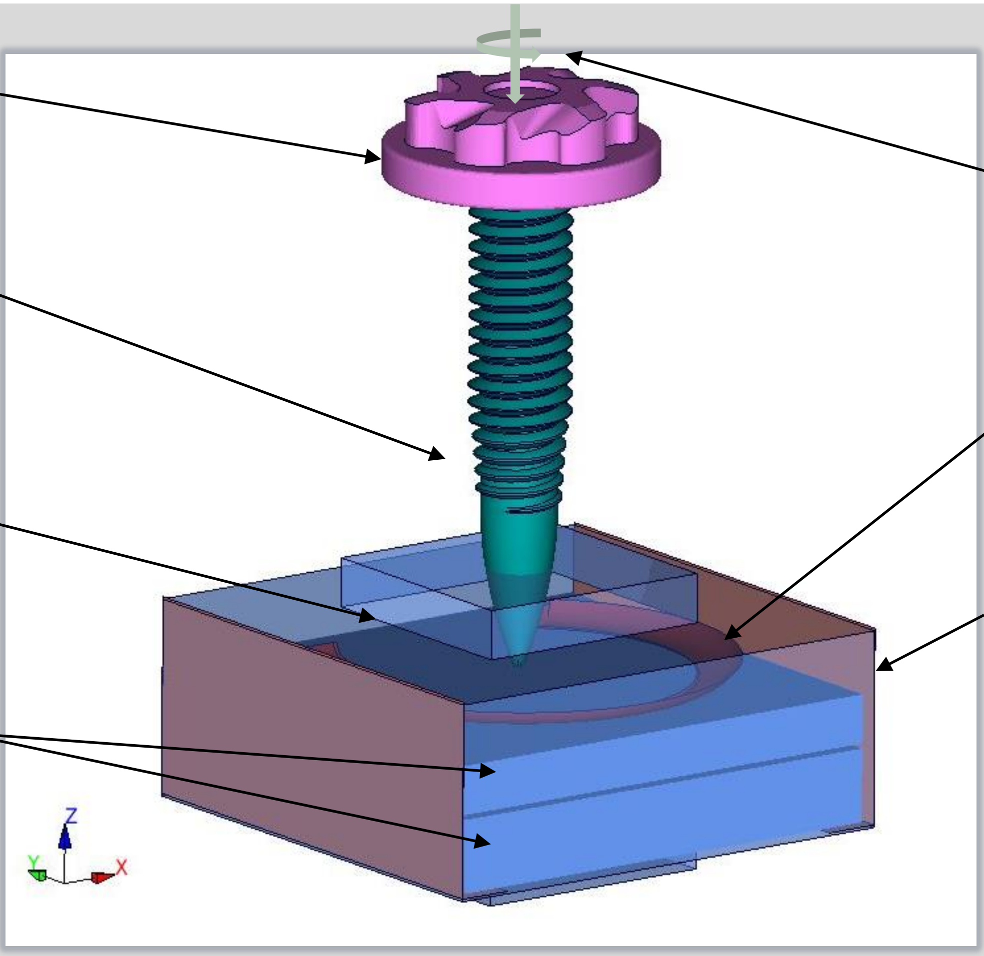
SIMULATION MODEL.
*DYNAMIC TEMPERATURE-DISPLACEMENT, EXPLICIT.

Srew Head:
Rigid Body Element for Visualizing

Screw Shaft and Tip:
- Discretisized with C3DT Tetrahedron Elements.
- Density * 1000 (Time Step)
- Minimal Element Length: 0.1mm

„Eulerian Sheet Space“:
- Eulerian EC3DRT SOLID Hexahedron Elements.
- Minimuml Element Length: 0.1mm

Sheets to Join:
- Sheets defined by Volume Fraction in „Eulerian Sheet Space“
- Top Part: CR440Y780T-DP 2.0mm
- Bottom Part: AL5STD 3.0mm
- Temperature dependent flow curve calculated by JMAT Pro



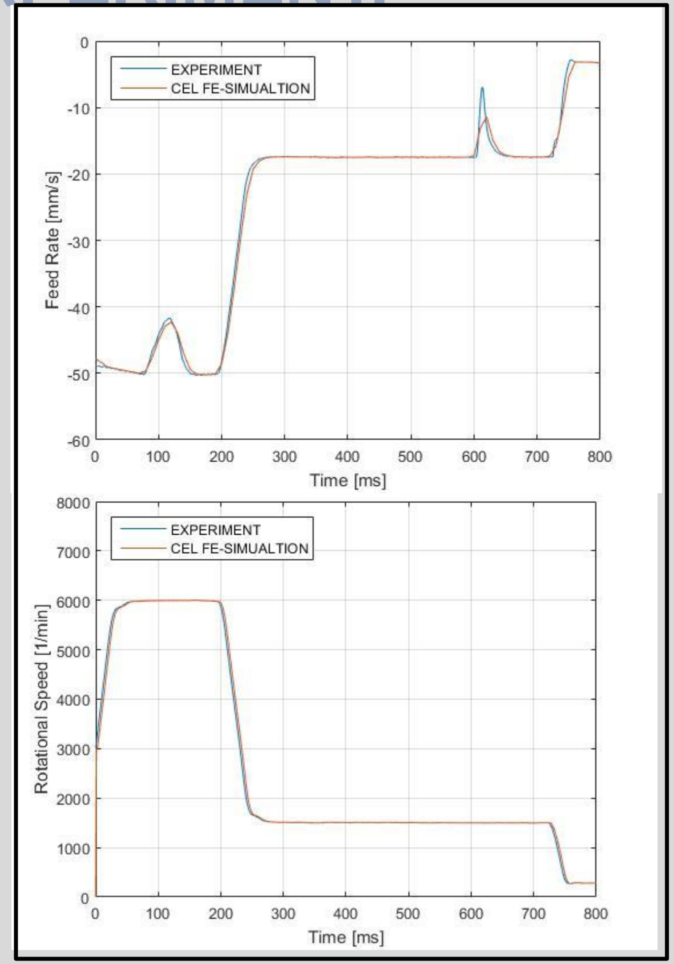
Joint (Input):
- Feed rate defined by Amplitude (Velocity-Time)
- Rotational Speed defined by Amplitude (Velocity-Time)

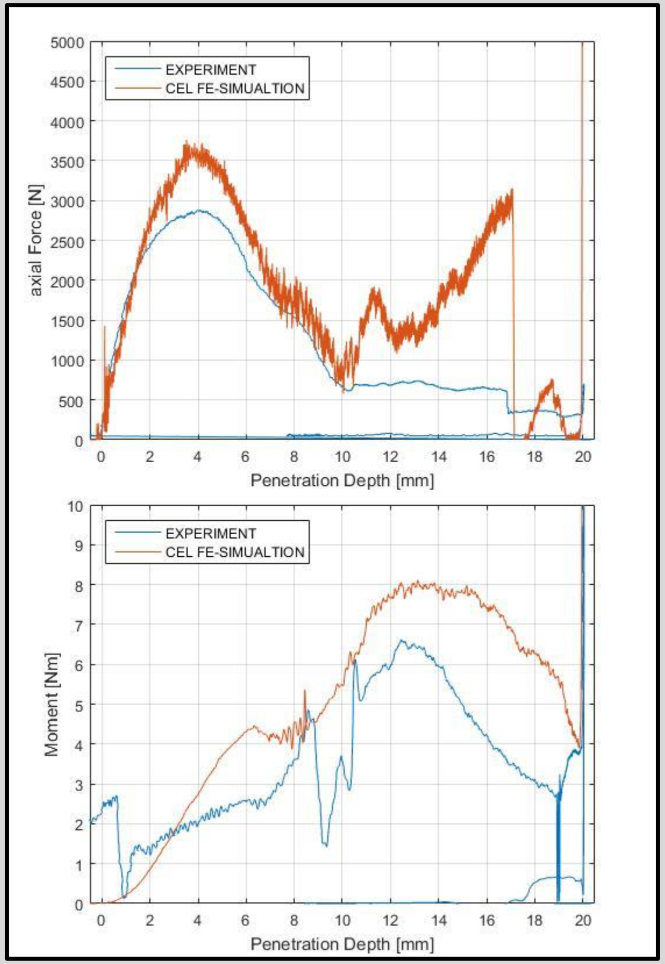
Tool Downholder:
- Rigid Body Element
- Downholder Force defined by constant Load

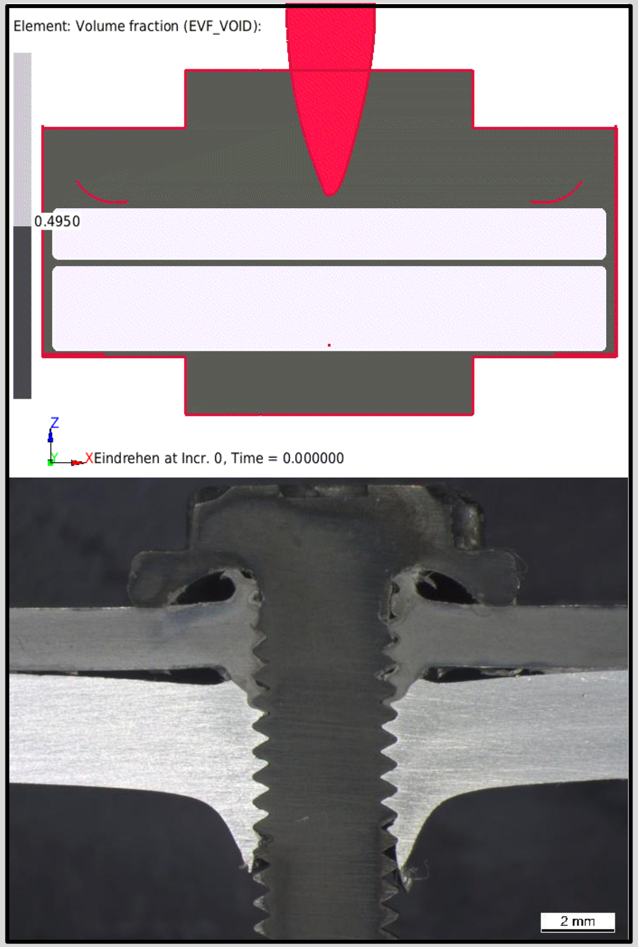
Constraint (Output):
- Constraint defined as a Rigid Body Wall
- Measure Reaction Forces and Reaction Moments via Joint

Contact Formulation:
- Standard coulomb approach with a constraint of the maximum friction shear stress.
- Gap Heat Generation

SIMULATION RESULTS.
COMPARISON OF SIMULATION WITH A FLOWDRILL PROCESS EXPERIMENT.







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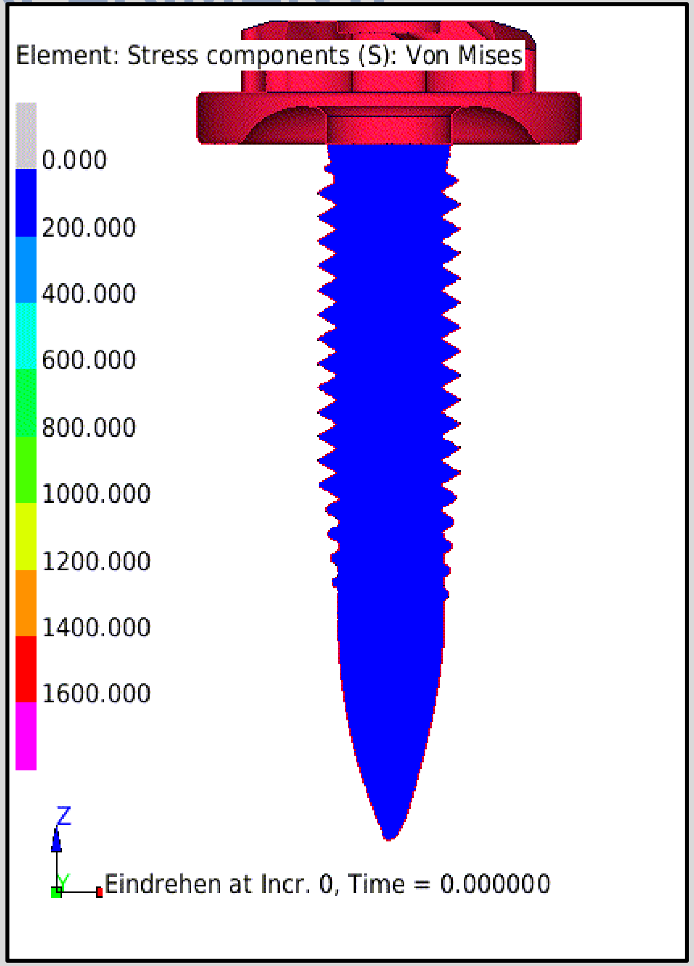
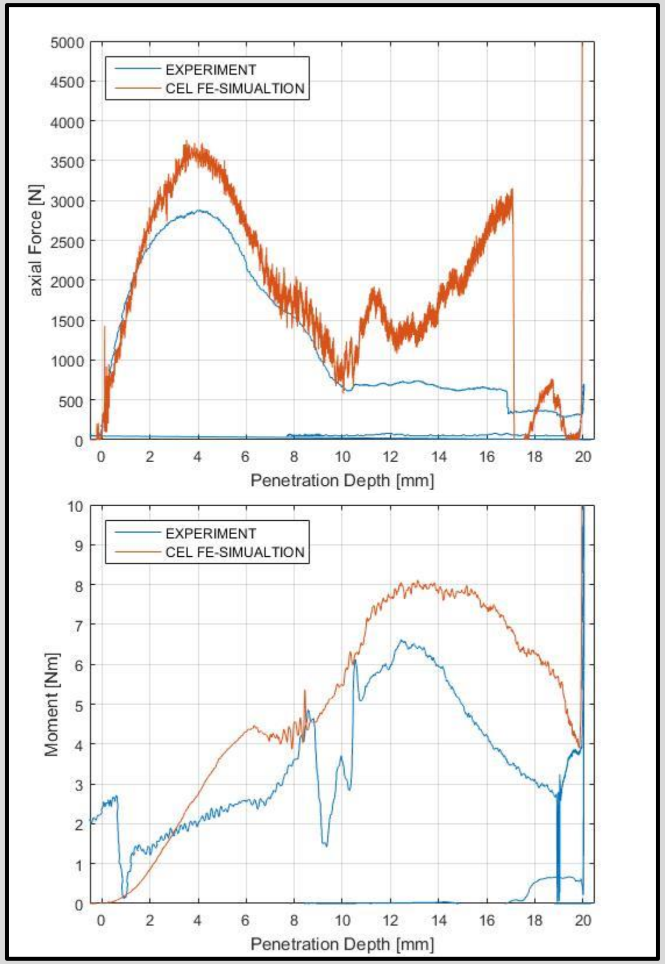
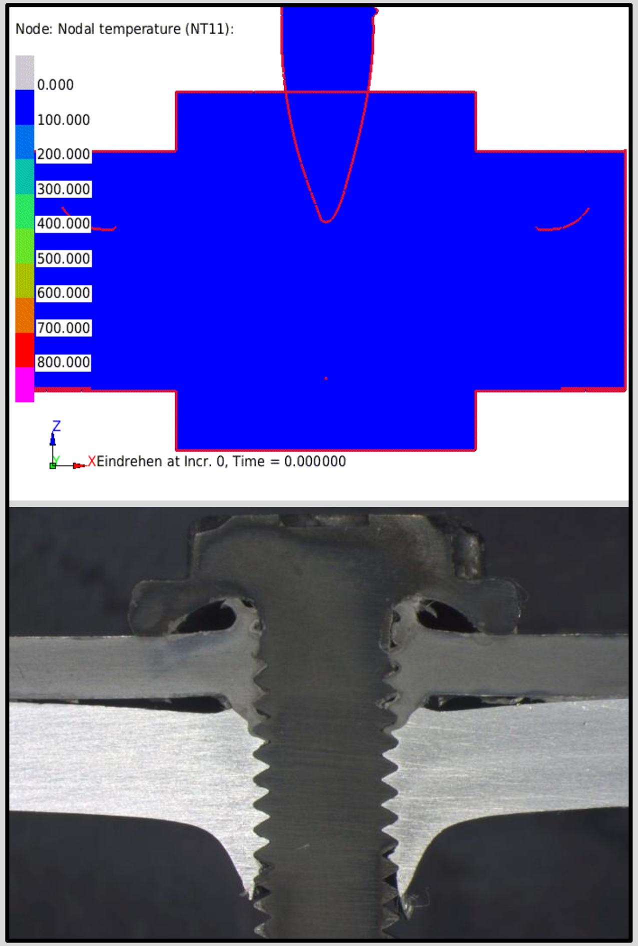
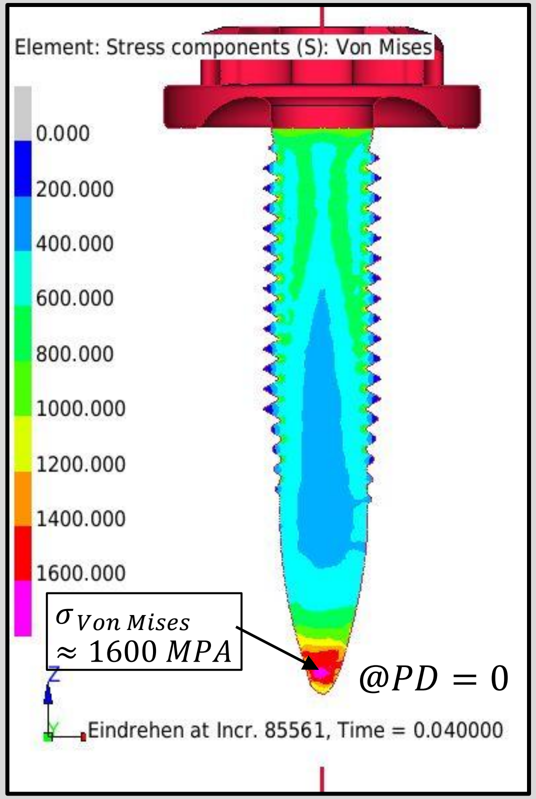
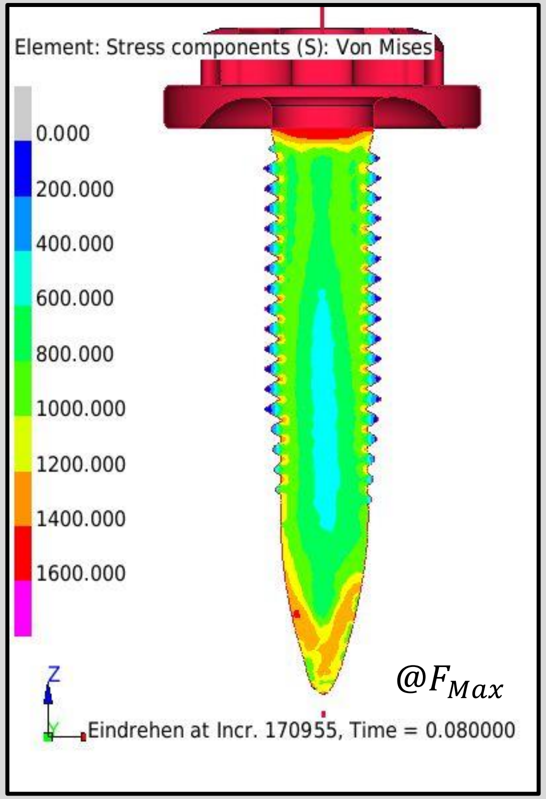


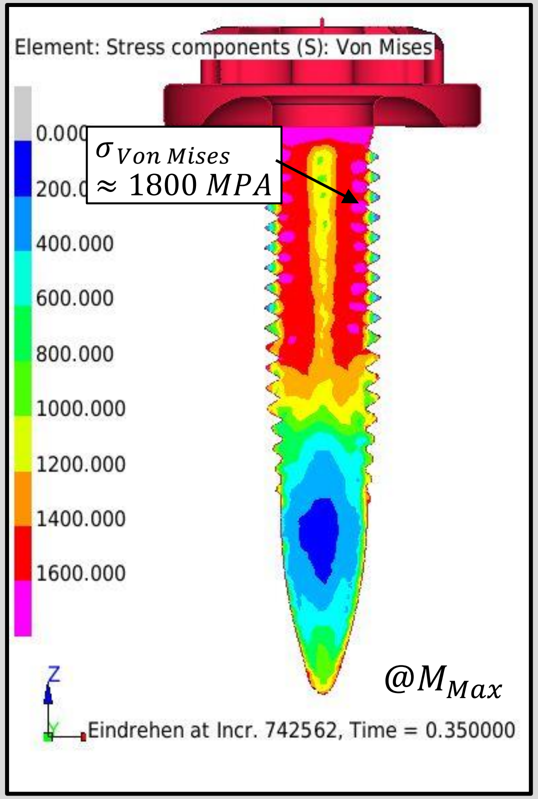


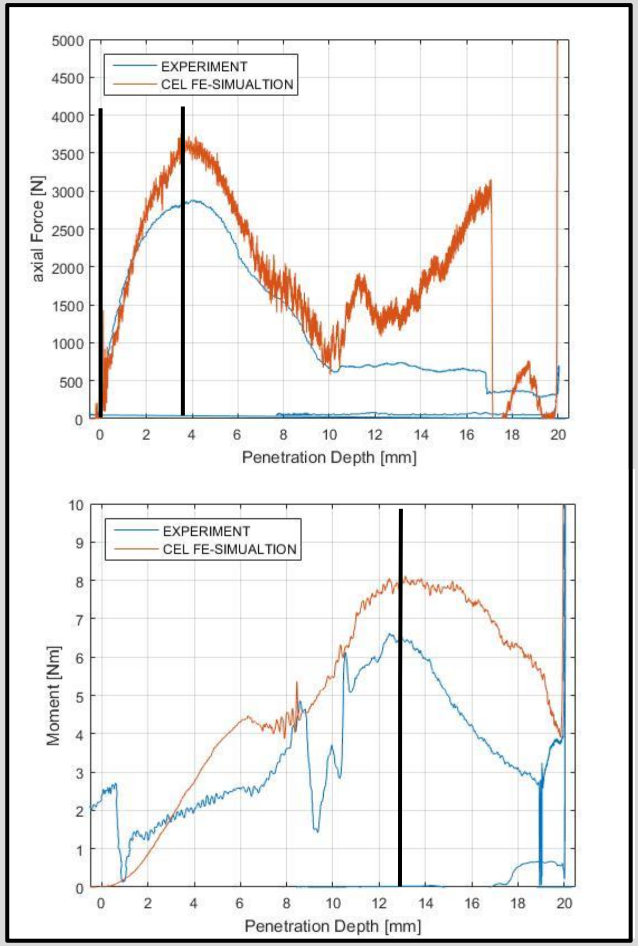


SIMULATION RESULTS.
STRESS ANALYSIS- REACTION FORCES AND MOMENTS.

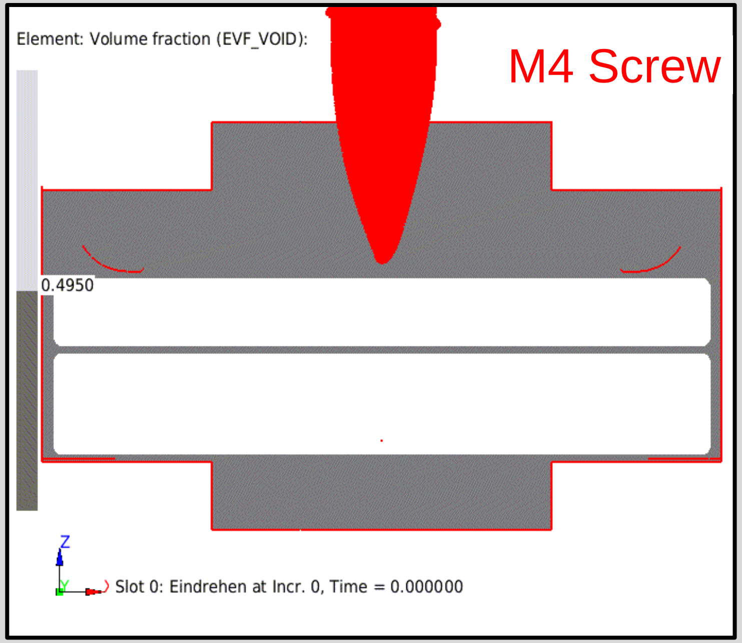


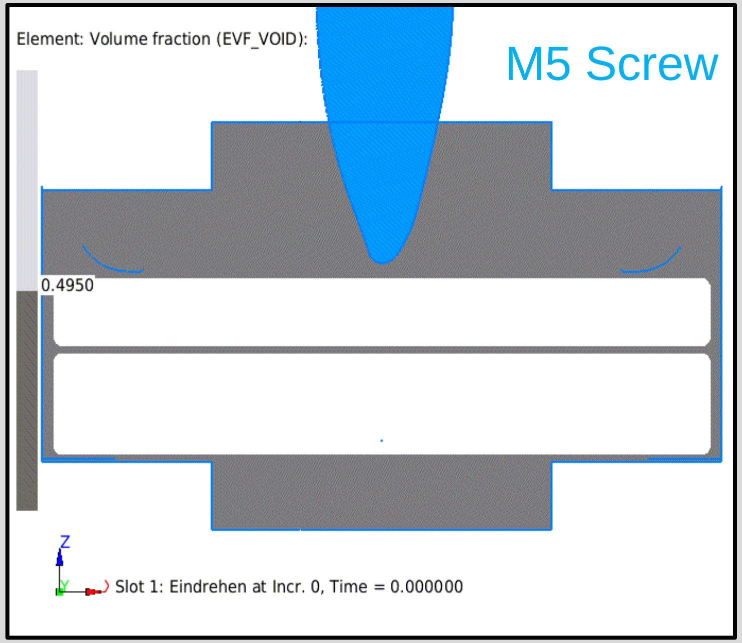


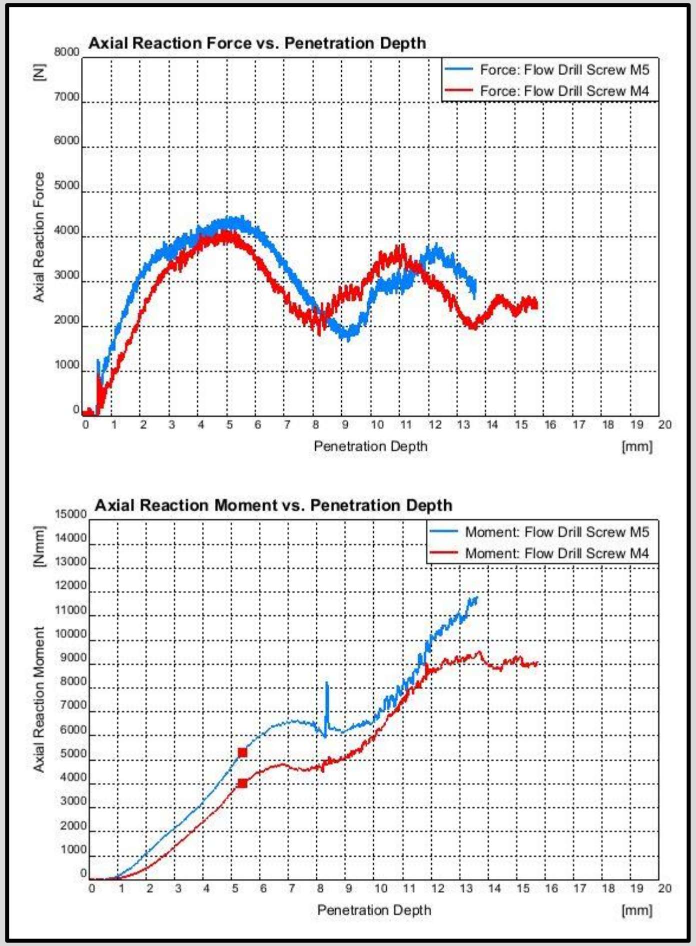




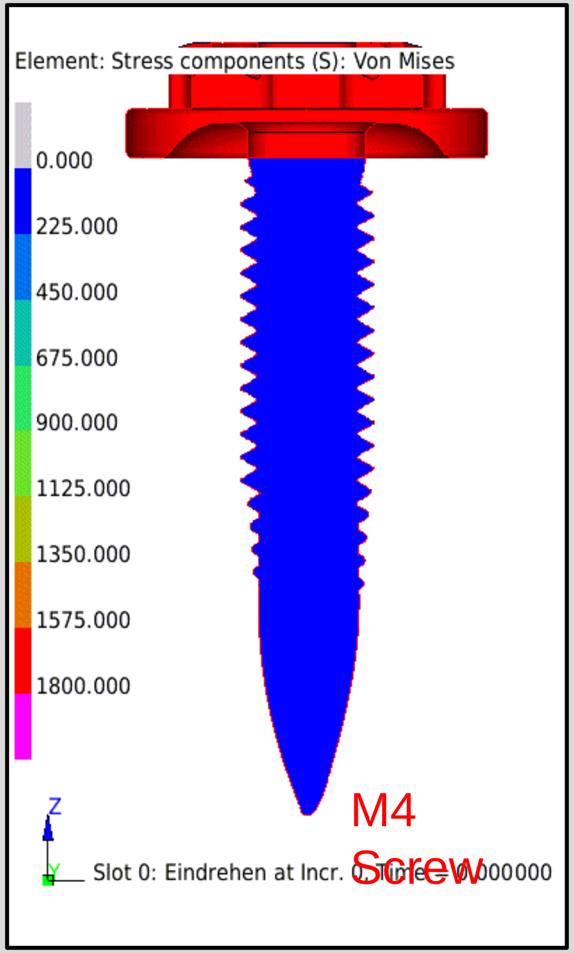
SIMULATION RESULTS.
VOLUME FRACTION - REACTION FORCES AND MOMENTS.

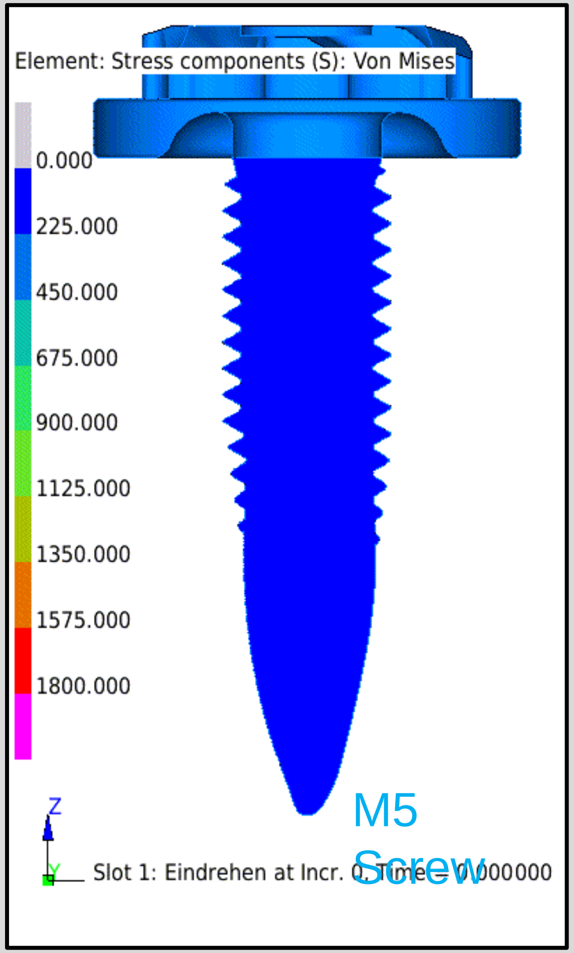


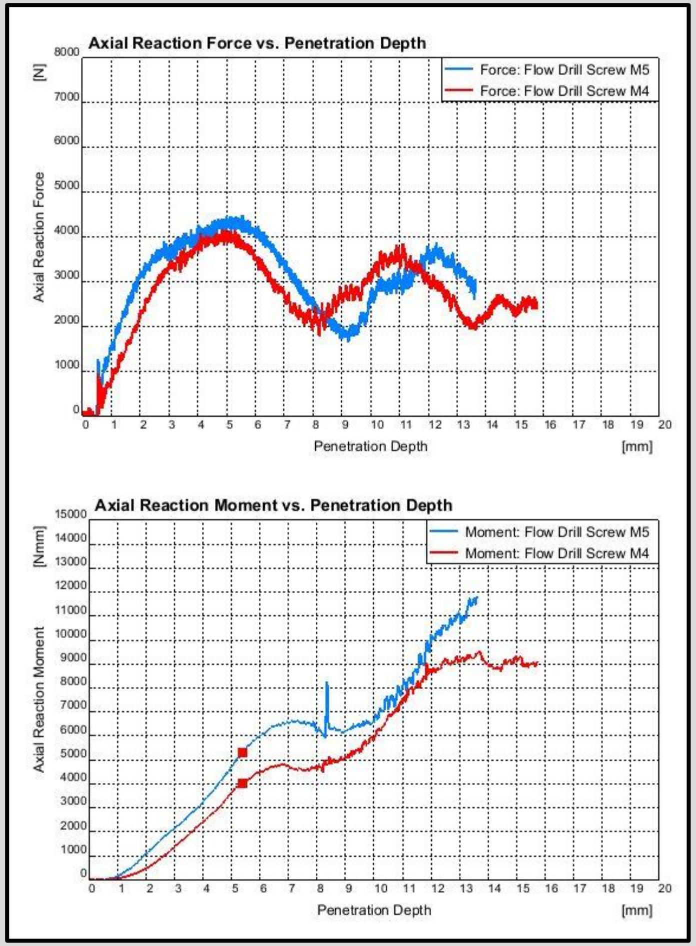




SIMULATION RESULTS.
STRESS ANALYSIS – REACTION FORCES AND MOMENTS.







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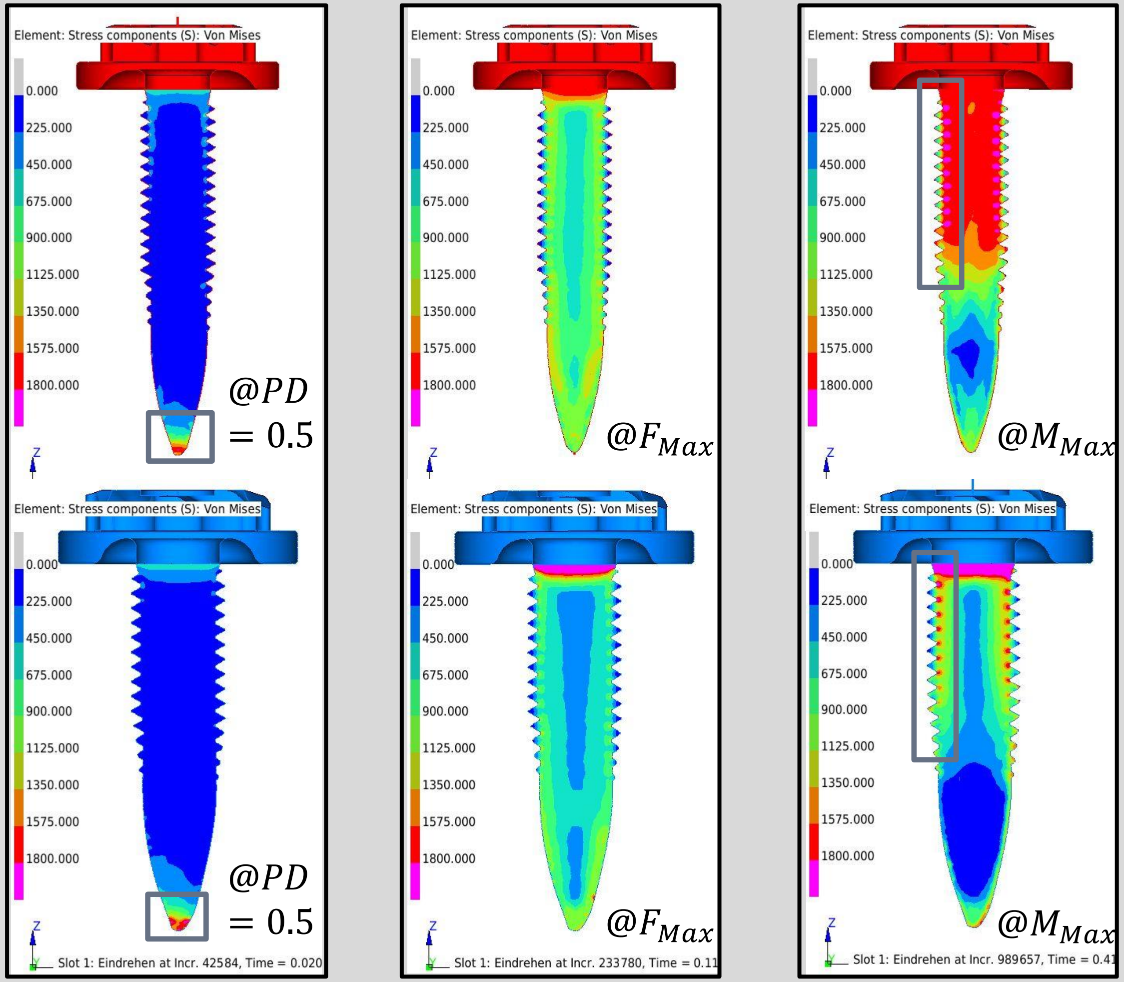
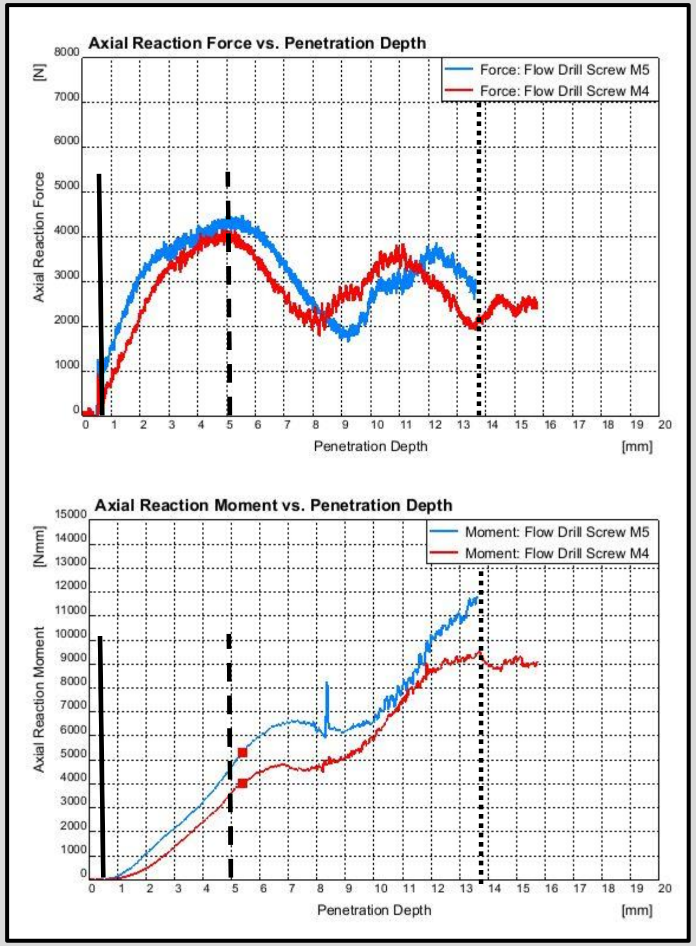


M4 Screw

M5 Screw



SUMMARY AND CONCLUSION.

- A Finite-Element-Model based on a coupled-Eulerian-Lagrangian Analysis in Combination with Dynamic Temperature-Displacement Explicit-Solver has been shown to simulate flow-drill-screwing process.
- A comparison to an adaptive velocity process has been shown as well as a first stress analysis.
- A mechanical stress Analysis of two Flow Drill Screw Types (M4 and M5) has been compared.

Conclusion.

- Stresses, reaction Forces and reaction Moments can be investigated as well as strains and temperatures.
- The Simulation can be used to develop new Screw Geometrys and new Process Parameters for prototyping to reach new process limits for the Flow-Drill-Screw Process.

BMW Group

Jonas Zweck; Thomas Richter

Production System, Cold Joining Techniques
Karl-Dompert-Straße 7
84130 Dingolfing

Mail: Jonas.Zweck@bmw.de
Web: http://www.bmwgroup.com/