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Defect identification and prevention in automotive component industry

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INTRODUCTION & AIM

The stamping process plays a key role in several industries, namely the automotive industry.

Although high-strength steels have shown excellent mechanical properties, there are drawbacks related to their formability, which are associated with the appearance of defects that compromise product quality.

With the intention of predicting the appearance of these defects, the industry has resorted to numerical simulation tools to study the behavior of materials when subjected to forming processes.

The focus of this work was to study the behavior of high-yield-strength steels and the potential of numerical modeling and the advantages of applying it to the simulation of manufacturing processes to optimize the process and eliminating or preventing the formation of defects.

The used Stampack software has proven to be very effective in preventing and resolving defects that arise during stamping. Through the wide range of features that Stampack offers, it was possible to recognize possible material breakage and risk factors.

METHOD

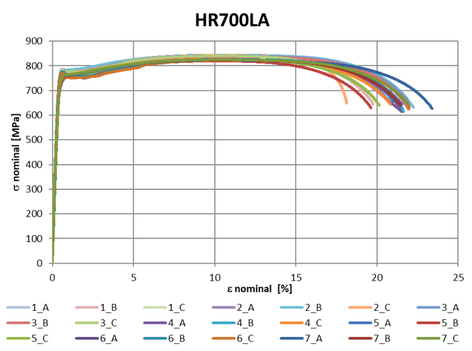
- The materials selected for this study correspond to the materials of three different components produced by KIRCHHOFF, which had a high and unexpected scrap rate;
- HR700LA steel is supplied by Volkswagen, while CR340LA and DP800 follow the guidelines published by FORD.

Properties/material	HR700LA	CR340LA	DP 800
Thickness (mm)	3	2	2
Yield stress min. (MPa)	700	340	420
Yield stress max. (MPa)	850	420	550
Tensile strength min. (MPa)	750	410	780
Tensile strength max. (MPa)	950	530	900
Elongation (min %)	13	20	14

RESULTS & DISCUSSION

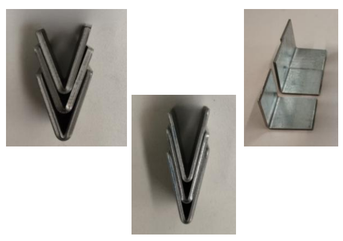
Tensile tests

- Quantification of the mechanical properties of the materials, which enables a more accurate numerical representation of them;
- Verification of possible variation in properties between different batches.



RESULTS & DISCUSSION (continued)

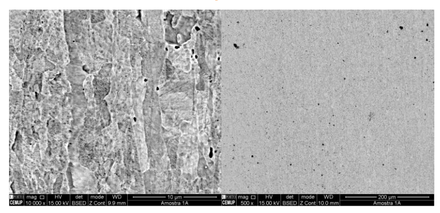
Bending test



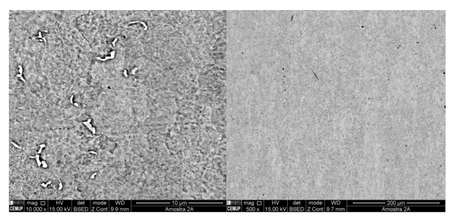
Material	Test	α (°)
HR700LA	1	149
	2	148
	3	150
CR340LA	1	150
	2	150
	3	150
DP800	1	89
	2	89
	3	86

Metalographic tests

Sample 1



Sample 2



Hardness tests

Points	HV hardness Unsolicited area	Solicited area
1	330,2	296,7
2	320,1	301,2
3	320,1	301,2
4	313,3	307,3
5	313,6	307,3
6	313,6	320,3
7	315,2	325,1
8	305,8	337,2
9	313,6	344,5
10	325,1	350,0
11	323,4	344,3
12	328,5	305,1

Points	HV hardness Unsolicited area	Solicited area
1	293,9	296,8
2	279,9	292,4
3	268,4	291,0
4	279,9	286,7
5	270,7	293,9
6	274,6	289,5
7	264,5	291,0
8	270,8	289,5
9	270,9	301,2
10	275,9	293,3
11	274,6	298,3

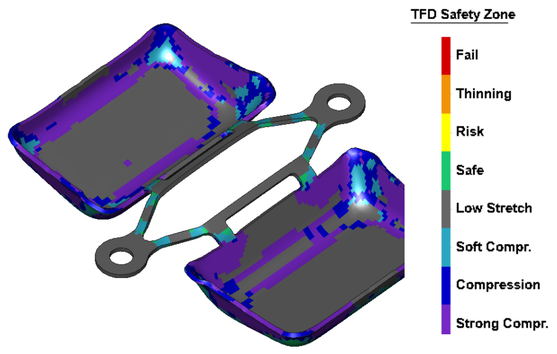
The simulations began by analyzing the experimental bending test on metal plates. This simulation provides accurate data on the structural behavior and material properties and is used to validate the numerical model;

No restriction to the movement of the specimen;

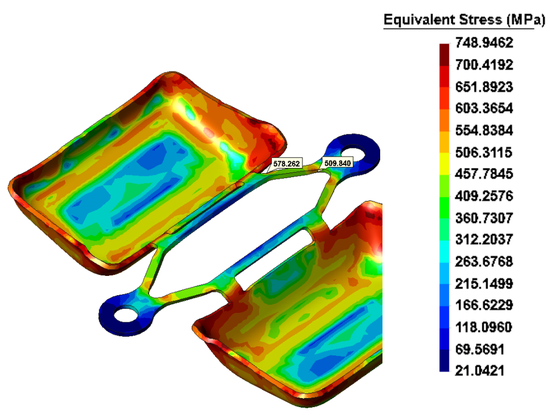
The contact between the plate is discretized by finite elements and the tool is always of the "no penetration" type with a friction coefficient of 0.1.

The triaxial rupture diagram shows that there is no risk of failure: the triaxial rupture coefficient in the critical zones is 58 and 50;

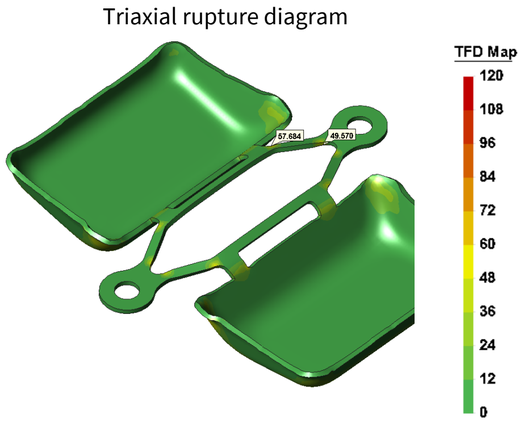
The equivalent von Mises stress at these locations is 578 and 510 MPa.



Triaxial rupture diagram



Von Mises equivalent stress distribution



Triaxial rupture coefficient diagram

CONCLUSION

Stampack has proven to be very effective in preventing and resolving defects that arise during stamping. After the analyses carried out, the geometry of the parts was optimized and the stamping tests proved the accuracy of the numerical results, with a 100% success rate of the components produced;

The numerical simulation revealed that, for component 14768, failure occurs at equivalent plastic deformation value 15.8% lower than those found in the bending tests on metal plates for CR340LA steel. However, this slight difference is acceptable on account of the complex phenomena in stamping processes and material defects in real stamping processes that favor material failure.