ТЕЗИ ДОПОВІДЕЙ ПЛЕНАРНОГО ЗАСІДАННЯ

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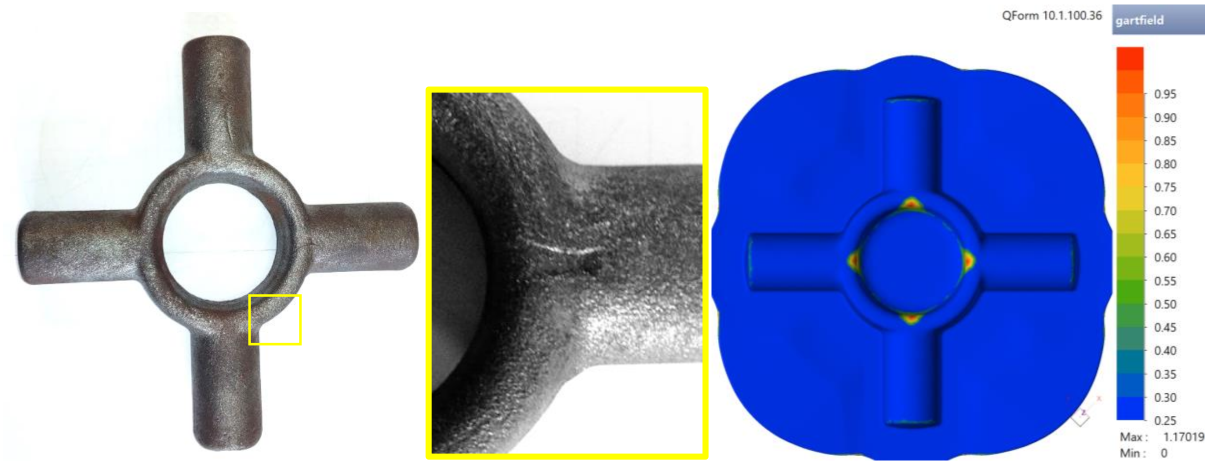
QFORM UK: AN ULTIMATE METAL FORMING SIMULATION SOFTWARE FOR THE INDUSTRY, EDUCATION AND RESEARCH

With more than 30 years of research and development in the field of finite element simulation of metal forming processes, our program “QForm UK” is one of the leaders in the world market of commercial engineering software. It is used by hundreds of companies and universities in all industrially developed counties worldwide. The latest version QForm UK 10.2 has improved interface and mathematical algorithms to simulate a wide range of metal forming technologies such as forging, rolling, extrusion and stamping in a hot and cold state. The program also provides the heat treatment and microstructure evolution simulation for steels, titanium, aluminium and nickel-based alloys. The program possesses advanced simulation features such as the dual mesh method, fully thermally and mechanically coupled tasks, damage prediction criteria for workpiece and tools, and low-cycle tool fatigue prediction. The fastest network and client-server workflow with multi-core and multi-task options give users the ability to design the best components in a virtual environment without costly shop trials.

We also developed a specialised CAD program for automated optimal preform design called QForm Direct (powered by SpaceClaim^{TM}) based on equipotential surfaces to generate the preform shape [1]. This program is integrated with the QForm UK program to verify and optimise the proposed preform shape by modelling the metal deformation in the actual forging process. Below is the case where we developed the best preform shape for hot forging a cross-like part. The original technology used a round billet with a diameter of 65 mm and a height of 118 mm made of steel 20MnCr56 (1.7147 DIN) heated to 1200^0 C. The equipment was a 25 MN mechanical press. The first operation was upsetting the billet to a height of 60 mm. Then the billet was forged in preforming dies that were designed according to traditional guidelines, having increased drafts and radii. Then finally, it was forged in the finish dies (Fig 1.). When using the original preform design, a lap occurs in the finish forging that is seen in the actual part (Fig. 1 a,b) and clearly detected by simulation (Fig. 1c).

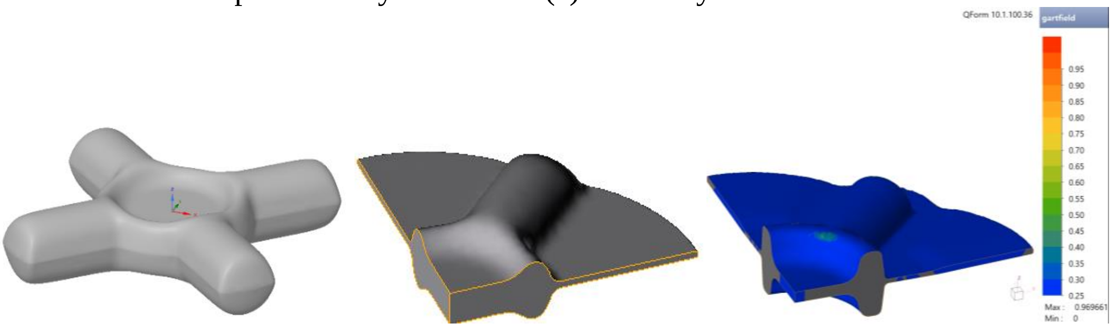
A new optimal shape of the preform was developed using QForm Direct software. The equipotential surfaces used for its creation are shown in Fig. 2a. The forging sequence using this preform shape was simulated, and it didn’t show any defect in the finished part (Fig. 2. b, c). After such verification using simulation, the preform dies were modified to the QForm Direct design and placed into production, while finish dies were left without any alteration. Trial forgings have shown the perfect quality of the finished part without any defect, as shown in Fig. 3. Moreover, modification of the preform allowed reducing the billet volume, saving the material by 6.7% and significantly reducing the die wear.

Several leading Ukrainian industrial companies use QForm UK. Some of them are NKMZ and EMSS (Kramatorsk) for heavy forged parts, Interpipe (Dnipro) for tube rolling, MotorSich (Zaporizzhia). The program is used by NMetaU, KPI, KhPI, Donbas Machine-building Acadamy and several other educational institutions for student teaching and research. The implementation of new simulation methods in the technology development increases productivity and improves the quality of products, saving energy and material in the manufacturing, which is vital for the fastest recovery of the Ukrainian industry and education after the War.



a) b) c)

Fig. 1 – Actual finished forged part: a lap on a general view (a) and magnified defect zone (b) and defect locations predicted by simulation (c) shown by red zones of Gartfield indicator.



a) b) c)

Fig. 2 – The preform shape is based on equipotential surfaces (a), simulation of preforming (b) and finish impressions (c) using the proposed preform. No defects in finish forging are detected, as shown by the distribution of the Gartfield indicator.

a) b)

Fig. 3 – Photo of the actual preform (a) and finished (b) forged parts using proposed preform shape (no material flow defects observed).

Literature

1. N. Biba, Automated preform design for hot closed-die forging, Metal Matters, CBM, UK 2022, Edition 62, pp. 11-12.