AFDEX Newsletter
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1. AFDEX_V18R02

1.1 New version plans and its features

AFDEX_V18R02 will be released on 14th of August. This new version is a patch version of AFDEX_V18R01 released in April this year. Major functions updated in AFDEX V18 are shown in the table below.

Table 1.1 New functions or improvements of AFDEX_V18

	Functions or improvements
2D and 3D	-Simulation considering die elastic deformation with shrink fit considered -Repetitive simulation between specific steps -Simulation considering elastic deformation of press -Analysis of heat transfer among assembled dies -Structural analysis of assembled dies -Control of penetration of material into the gap between dies -Calculation of shortest distance between nodal points and dies -Improved computational speed -Improvement of node separation algorithm -Improved Brozzo damage model -Function of contact exclusion during structural analysis of assembled dies -Prediction of hardness based on experimental formula -Improved heat transfer analysis function -Improved frictional conditions as a function of temperature, pressure and strain -Improved heat transfer coefficients as a function of temperature and pressure -Local mesh density control -Improved initialization of material at each stage -Function of limited temperature increment per step -Improved coupled flow analysis with damage -Treatment of rigid-body motion of material and die -Forced remeshing before new or continuing run -Material removal function -Improved Freudenthal damage model -Microstructural evolution prediction function -Heat treatment analysis function
2D	-Boolean operation -Process design optimization using HyperStudy -Improved determination of the final stroke when non-standard dies are employed -Improved mesh density control of dies -Die geometry defined by a connection of die points -Improved description of dies -Improved convergence of multi-body function
3D	-Improved computational speed -Improved function of pusher in open-die forging including rigid body condition -Improved algorithm of step size and contact for open-die forging -Improved mandrel control for swaging, radial forging, and open-die forging -Improved algorithm for separating contact node -Improved temperature analysis in dwelling/transferring -Addition of stroke control based on distance when axisymmetric die is used in 3D -Improved rotating die function -Improved non-isothermal analysis of a screw/hammer forging process -Hydrostatic forming function -Air trapping treatment -Improved pusher for open-die forging -Improved initialization of state variables -Composite material treatment -Improved function of ring rolling simulation -Evolving function of a rotating die -Specialized remeshing for ring rolling simulation -Compensation of volumetric change due to remeshing -Elementwise compensation scheme for volume change -Back pressing function of manipulator and pusher -Exact positioning of periodically moving die -Practical 3D point tracking -Improved open-die forging function -Multi-body analysis without remeshing (Manual) -Larger scale problem solver -3D quantification of grain flow (metal flow lines)

2. Application case

2.1 Process design optimized by grain flow

AFDEX can obtain the optimized process design considering metal flow lines by using the quantification technique of grain flow developed in the metal forming CAE laboratory of Gyeongsang National University and commercialized by MFRC. Along with Altair's HyperStudy, AFDEX can currently optimize the 2D axis-symmetry process design. The development is under progress for 3D processes.

As an application example, it was applied to the forging process of first-generation hub bearing outer race which strictly requires symmetry of the metal flow lines. Fig. 1 shows a 3-stage forging process with emphasis on the stroke distance(s) of the blocker process, one of the design variables.

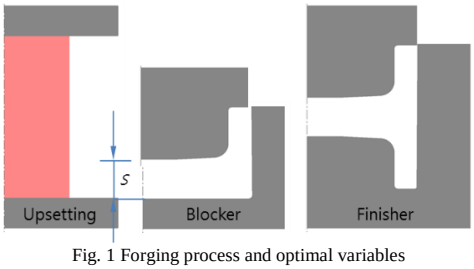


Fig. 1 Forging process and optimal variables

There may be various methods of satisfying the symmetry of the metal flow line, that is, the method of setting the objective function. In this example, we used the simple but fundamental method of using the grain flow function itself as the objective function. That is, if the metal flow line function defined at two points lying symmetrically in the final shape, as shown in Fig. 2, that is, the initial x-coordinate, is equal, the metal flow line in the final shape satisfies the symmetry with respect to the central horizontal line. Therefore, the difference between the grain flow function values defined at the two vertically symmetric positions in the final shape is defined as the objective function. Using the automatic optimization function, the optimal process design was achieved after about 4 hours of calculation without any user intervention.

Both AFDEX 2D and 3D are suited well for process optimal design because of its powerful automatic analysis function.

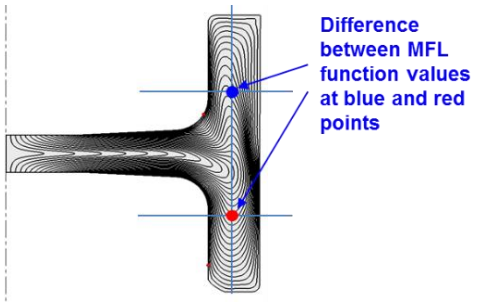
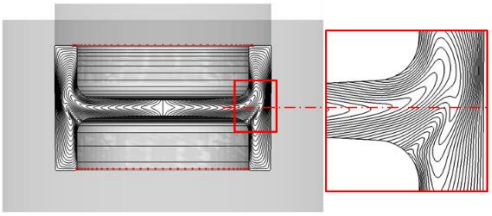


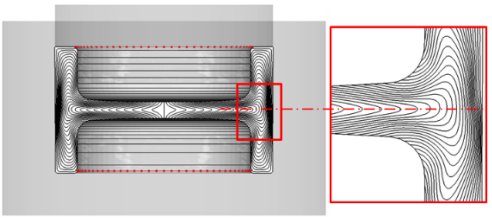
Fig. 2. Optimal design objective function

Fig. 3(a) shows the analysis results of the initial design just before the process optimization, and Fig. 3(b) shows the analysis results of the optimized process design. It can be seen from the optimum design result that the grain flow optimization technique can be applied further to a considerably useful application.

Currently, the optimal process design technology considering the metal flow lines is being researched and developed in different dimensions. AFDEX is expected to advance in this field because the technology of visualization and quantification of the metal flow lines is a unique technology of AFDEX. We would like to invite users to actively pursue joint application studies and to promote the application of optimal process design.



(a) Initial design



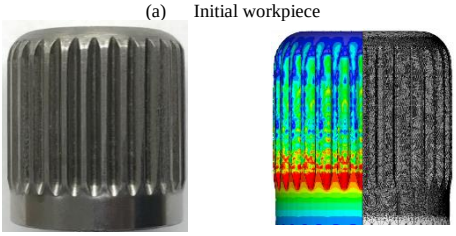
(b) Optimal design

Fig. 3 Optimal process design by consideration of grain flow

2.2 A Study on Axial Forming of Thin Walled Hollow Shaft

AFDEX is frequently used for axial shaping of tube shaped parts (P. Grupp, 2012, ICFG 2012, Nagoya Japan, 9-12). An example is a case in which the end of a pipe is extruded to form a shape or to form a spline. If the pipe or hollow shaft material is long, it may be necessary to fix the unsupported region of the material during forming. In this process, the influence of the material clamping force cannot be ignored. Because, in order to support the axial forming force, a frictional, tangential force must act and in order to maintain it, exerting radial force is essential and this force, together with the axial forming load, can cause plastic deformation of the material around the end of the clamping tool. Fig. 4 shows an example of recursive axial forming.

(a) Initial workpiece



(b) Splined end

Fig. 4. Recursive axial forming

Traditionally, velocity or displacement constraints are imposed on the part supported by the clamping tools to analyze such forming processes. Of course, if the opposite side of the material is simply supported, the traditional analysis model is valid. However, the situation is very different for materials that are mechanically weak in the radial direction due to their small thickness. Here is an example showing the limitations of the traditional analysis model.

Fig. 5(a) is an axisymmetric elasto-plastic finite element analysis model of an axial forming process in which an axial load of 100 kN is applied on the top of hollow stepped shaft. Fig. 5(b) shows effective stress at the final stroke when the clamping jaw is idealized by applying a load in the axial direction. Fig. 5(c) shows the analysis result of the traditional case in which the clamping device is modeled by the constraints deleting the longitudinal degrees of freedom of the material. From the distribution of effective stresses in Fig. 5(c), it can be concluded that the actual process is appropriate. However, Fig. 5(b) indicates that the process cannot be stable because of the clamping force. For example, to

support an axial load of 100 kN, a radial force of about 550 kN was applied for Fig. 5(2). In other words, the stress is greatly increased by the clamping device, which can lead to defects depending on the situation. Therefore, minimization of the forming load is very important in axial forming of long thin wall hollow shaft or pipe. Note that recursive axial forming using oscillatory motion imposed on the die is one example.

The use of axisymmetric or 2D function is strongly recommended for this kind of simulation. This is because, in the case of three-dimensional finite element analysis, especially in the elasto-plastic finite element analysis, there is a limitation of the dense mesh generation, but the sophistication in processing the symmetric condition is inevitably reduced in 2D. If it is a problem that can be solved, the use of the 2D function is recommended from an engineering standpoint.

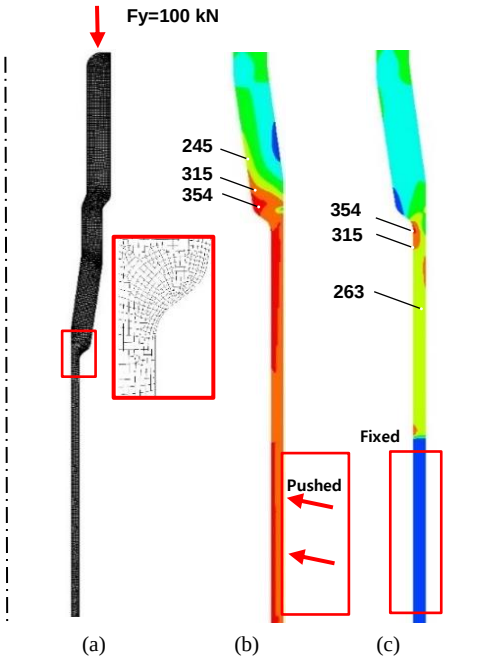


Fig. 5. Stress (MPa) acting on the material by the same load (100 kN) with or without considering the clamping force. (a) FE model, (b) With clamping device considered, (c) Fixed boundary conditions for clamping jaws.

3. Notice

3.1 MFCAE 2018

MFCAE 2018 will be held at Jinju MBC Convention from 16th to 17th of August, which will be one of the main user conferences of AFDEX. MFCAE has been held as an international event since 2014 as a metal forming CAE technology conference organized by Gyeongsang National University. But it has been happening domestically in Korea since 1996.

The feature of this event is that it focuses on education. In the morning of the first day, there will be an opportunity for the undergraduates participating in GISPAM 2018 to present (25 Mexicans, 2 Malaysians, 10 Koreans), and in the afternoon, developers will spend 8 hours in detail for further education and discussion. In the morning of the second day, a graduate session will be held and about 15 research and application examples with research ideas or plans will be announced and discussed. At the same time, in the morning, users, divided into several teams, will receive previously requested and customized trainings on special topics and/or functions. If additional training is needed, we plan to conduct inquiries and responses or special skills training until the afternoon of the second day. A total of 100 participants will be presented with the textbook "Metal Forming simulation (Mansoo Joun et al.)" on a first-come-first-serve basis.

Participate actively to learn how to use simulation software and gain more expertise. Please contact Ms. Vivian(jelee@afdex.com) or visit www.afdex.com.

3.2 International exhibitions

3.2.1 Hannover Messe

MFRC exhibited AFDEX at Industrial Supply Hall4, H48, Germany Hannover Messe exhibition from 23rd to 27th of April. According to the statistics of the Hannover Messe 2018, about 5000 companies from 75 countries exhibited and about 210,000 visitors from 90 countries visited the exhibition. Many visitors enquired about the functions of AFDEX, the difference between AFDEX and other SW and showed immense interest in using it. The ease of using AFDEX at first look was very appealing to majority of our stall visitors.

3.2.2 EATC

Altair's European Technology Conference will be held in Paris, France from October 16 to 18 for three days. The show will be a major PLM technology exhibition in Europe attended by experts from various fields. MFRC will introduce some new features of AFDEX during this event.

3.2.3 EuroForge 2018

EuroForge conFAIR 2018 will be held for three days from November 13 to 15 in Berlin, Germany. It consists of exhibitions of industrial companies in forging industry, presentations on latest forging technology, light weight, Industry 4.0 and global market trends. MFRC will participate as a platinum sponsor and will also present the importance of process optimal design and share some interesting industrial examples at the conference.

3.2.4 North American marketing event

Recently, the number of users of AFDEX in North America is increasing, and about 250 people visit AFDEX homepage in North America every day. To meet these North American interests, we plan to hold marketing events at the Altair's headquarters and Mexico City around October this year. At Altair, we plan to hold training and consulting events for APA users. In Mexico, we plan to hold meetings with prospective customers in the presence of our distributors.

3.3 GISPAM 2018

GISPAM 2018 will be held at Gyeongsang National University for five weeks starting on July 16. It is an international educational event in which 25 distinguished students from Mexico, 10 Korean university students and 2 university students from Malaysia participate. All Mexican participants' budgets are supported by the State of Mexico government.

GISPAM is the fifth international event of the year, started by the government of the State of Mexico five years ago, requesting AFDEX training for the best scholarship students in the State of Mexico (within the top 5%). From the second year onwards, it has been extended to selected Korean CAE software education. This year we plan to further strengthen AFDEX education at the request of the State of Mexico.

The subjects to be lectured consist of mechanics with some fundamentals including mathematics, statics and solid mechanics, engineering plasticity, finite element method, CAD practice, AFDEX practice and creative application, technical writing and presentation. All lectures are conducted in English. In addition, we will provide students with useful training experiences by visiting companies and experiencing traditional Korean culture. If you are interested in this program, please contact Vivian (jelee@afdex.com).