AFDEX Newsletter
2016 Spring

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1. New Enhanced Functions

1.1 AFDEX Version 70

The AFDEX 70 version to be released in May, 2016 includes such advanced functions mainly demanded by users throughout the whole year of 2015, whose special features cover those for the die structural analysis, an improved prediction of metal flow line, both capabilities of rigid-plastic and elastoplastic finite element analysis with due consideration of an elastic die deformation.

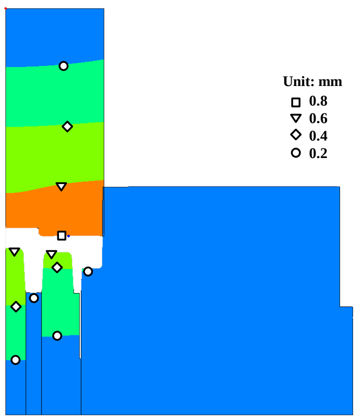
As simple revisions are already introduced in our previous newsletter (winter 2016), the rest of notable things will be treated in the user's manual and tutorials for self-learning, and such critically revised functions are, meanwhile, dealt with in this newsletter.

1.2 Main functions in the new version

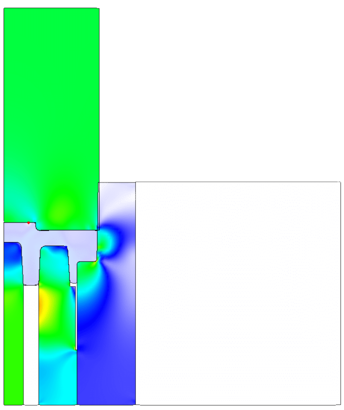
1.2.1 An elastoplastic finite element analysis with an elastic die deformation

Figure 1.1 shows the elastoplastic analysis result in the die for an axisymmetric cold forging process, shown noticeably in terms of induced displacements, stresses together with the shrink-fit case.

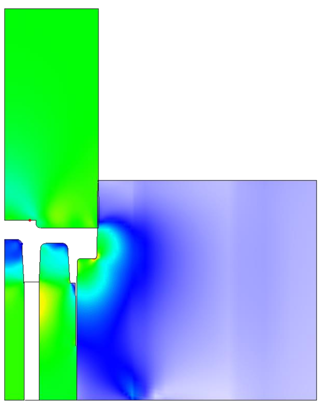
Figure 1.2 shows the cold forging analysis results for the residual stress caused by spring back, elastic recovery displacement followed by unloading, and die stresses in a typical bevel gear. The simulation is performed by the elastoplastic finite element analysis in consideration of an elastic die deformation.



(a) Die displacement

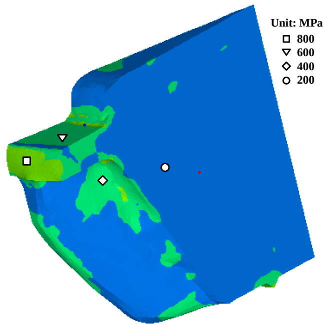


(b) Stress in the dies

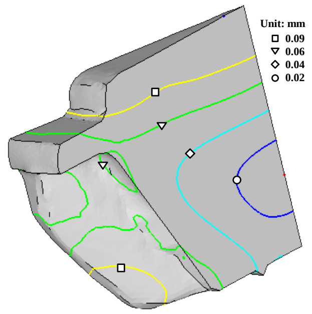


(c) Stress induced in a die (shrink-fit)

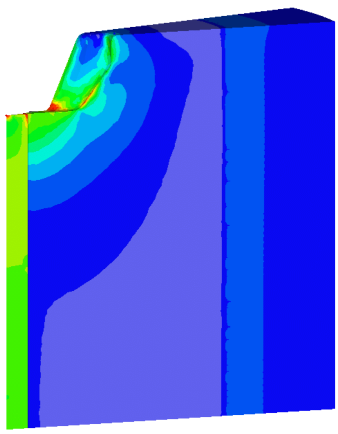
Fig. 1.1 Elastoplastic finite element analyses of an axisymmetric cold forging process with an elastic die deformation



(a) Residual stress



(b) An elastic recovery followed by unloading

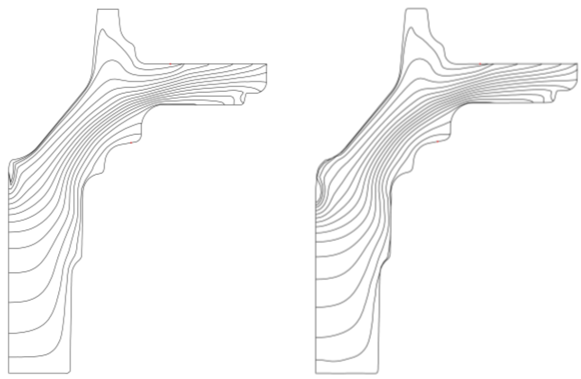


(c) Stress induced in a shrink-fit die

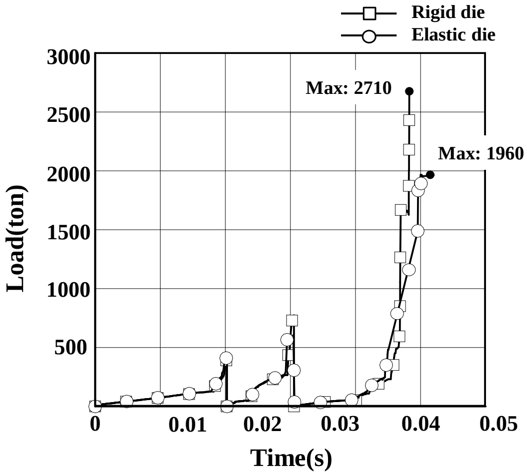
Fig. 1.2 An elastoplastic finite element analysis with an elastic die deformation

1.2.2 A rigid-plastic finite element analysis with an elastic die deformation

Figure 1.3 shows the rigid-plastic analysis result in the die for an axisymmetric hot forging process, in which the forging load in the model of an elastic die is about 30% less than that of a rigid die case. A piping defect at the central region is more distinguishable in the elastic die case. This phenomenon eloquently illustrates the reason why the rigid die model may not properly predict the real process due to the notable analytic inability when compared to the elastic model.



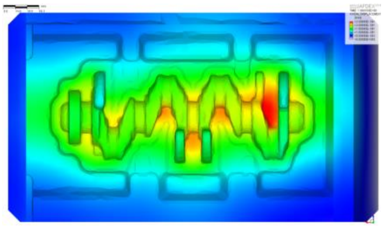
(a) Comparison of metal flow lines for the rigid die case (left) and the elastoplastic die (right)



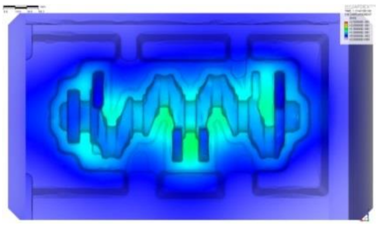
(b) A forming load-displacement curve

Fig. 1.3 A rigid-plastic finite element analysis with an elastic die deformation in an axisymmetric hot forging process

Figure 1.4 and 1.5 show the rigid-elastic finite element analysis results in a crank shaft coupled by an elastic die deformation, in which the metal flow lines and distribution of effective stresses are depicted in a detailed way. Similarly observed in the case of 2D analysis, the forming loads rapidly come to rise as soon as material starts to fill the empty space. Meanwhile, if the elastic deformation of die is considered, the sharp rise of forming load also induces an elastic deformation in the die, ultimately retarding the rise of the required forming load in a large amount. The analysis predicts maximum displacement of 0.13 mm in the die, while the overall metal flow line is quite similar to the result made by the rigid die model.

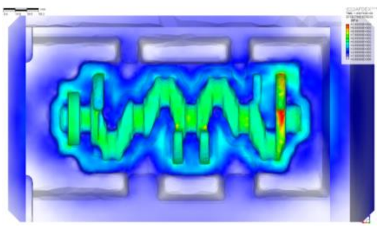


(a) A rigid die

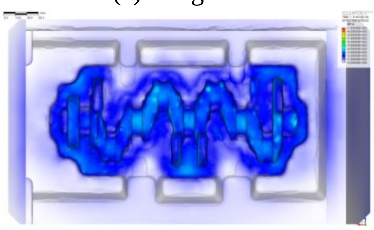


(b) An elastic die

Fig. 1.4 Die displacements in the rigid and elastic cases



(a) A rigid die

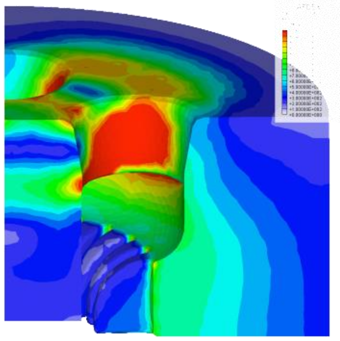


(b) An elastic die

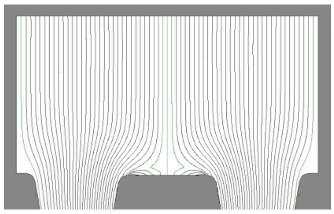
Fig. 1.5 Residual stresses in each die model

1.2.3 A Pothole extrusion process with an elastic die deformation

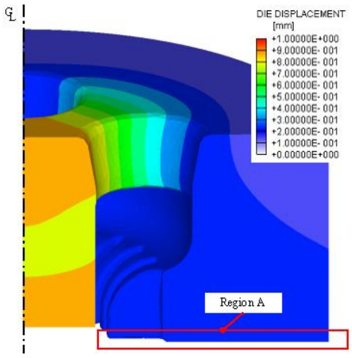
The effective stress, metal flow lines, and displacements in the die are depicted in Fig. 1.6 distributed in the material and dies during the pothole extrusion process with the die elastically deformed.



(a) Effective stress



(b) Metal flow lines



(c) Displacements in the die

Fig. 1.6 A rigid-plastic finite element analysis of the pothole extrusion process with an elastic die deformation

1.2.4 Detailed structural analysis of 2D axisymmetric dies

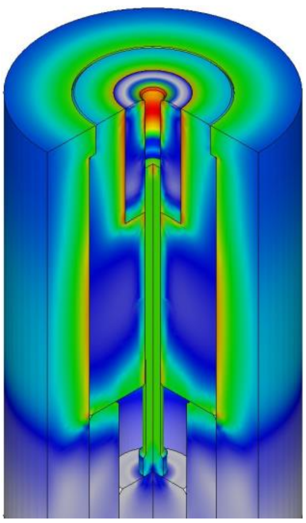


Fig. 1.7 An exemplary structural analysis of an axisymmetric die

Figure 1.7 shows an example of structural analysis for a pre-pressurized axisymmetric die. Up until the version 69 there have been constraints upon the mesh configuration in order to improve the solution accuracy when analyzing multi-body elastic problems.

And it might well have caused some applicative difficulties so that only the most professional users performed the relevant simulation in a limited range. The version 70 is now equipped with an optimized contact algorithm, nicely eliminating those constraints on the meshes which is readily available to any kind of users. Please note that the function mentioned is only applicable in the die analysis module.

1.2.5 Detailed structural analysis of 3D dies

Fig. 1.8 shows the simulation result for 3D die structural analysis. When using the option for a shrink ring in the existing version, some rare occasions are reported in which no rings are generated. And the related routines are now enhanced so as to yield no such undesirable cases.

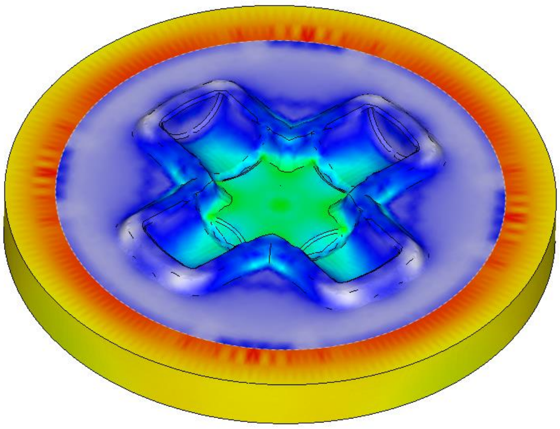
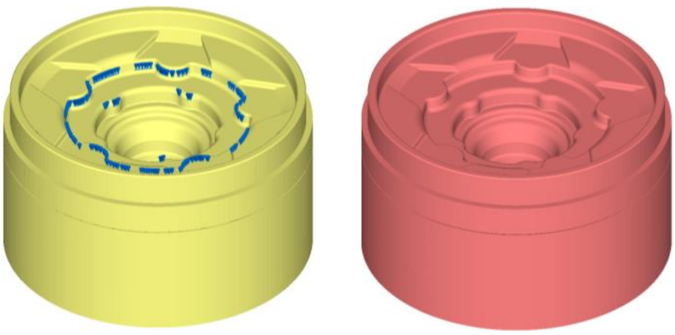


Fig. 1.8 A simulation result in 3D die structural analysis

1.2.6 Modification of 3D models with geometric issues

Geometric shape information usually in forging simulations needs to be admissible to the common computer environment. However the information from hot forging companies and sheet metal producers is known to be generally very complicated so that it is frequently not admissible when exported in .stl file format. If the material geometry is not sound, it ultimately leads to the mesh infertility in the initial work-pieces and makes the simulation not feasible. Note that a node contacts an unhealthy portion of the surface in a die and the simulation suddenly gets deteriorated. And the mesh infertility finally renders the simulation impossible, as easily seen in the non-isothermal analysis and die structural analysis as well. In such cases mentioned above, existing versions of AFDEX used to give a warning message by 'NON-Manifold triangles' or 'Triangular surface is open'. And users correspondingly have been obliged to modify those geometric errors in their specific CAD software with some considerable amount of time loss.



(a) Before (b) After

Fig. 1.9.3 A 3D Model with errors and its modification

Based on 3D printing technology Microsoft recently demands the automatic installation of the application of '3D Builder' when users try to install 'Window 10', meaning that every Window 10 user has the free access to '3D Builder'. That is, when users excecute '3D Builder', import .stl file, input the data for unit set-up and then encounter such geometry error messages from the troublesome .stl file, they may automatically rectify the problem by simply clicking the relevant modification button.

With this useful function is now easily resolved one of the enigmatic problems engineers suffered in the past from a great deal of time loss induced.

Please be kindly advised that main revisions and improvements contained in the AFDEX version 70 are also to be published concretely in the papers of the 2016 Spring Conference of KSTP.

2. AFDEX Developers Meeting in 2016

The 1st AFDEX Developers' Meeting was held on Jan. 6th at MFRC's Pangyo Laboratory with totally 15 researchers present. The crucial topics in this year were enthusiastically discussed, which comprise the subjects for an innovative upgrading of pre- and post-processor, the successful commercialization of an elastoplastic module covering an elastic die deformation, modules for the heat treatment, metallurgical analysis, and sheet metal analysis, while more active international research cooperation and its detailed action plans were also discussed.

Nearly all afore-mentioned topics are well ahead of the initial timetable, as a number of reliable results are coming to reality especially from the analyses of elastoplastic problems with die deformation involved, while their relevant functions are embedded in the form of AFDEX beta version 70. Under the collaborative development with a professional outside company is an innovative pre- and post-processor, and a joint research project for handling with an evolving metallic structure is going on through the service contract with Purdue university in the United States.

Maintaining the current close cooperation with Altair, AFDEX is noe on the more advanced track with the company shaping itself from the simple conventional function service provider to a one-level higher business partner, in which AFDEX will turn out to be an indispensable member of Altair's new total manufacturing-design system.

3. An invigorated international cooperation

Supported by the two times of GISPAM program held under the control of MFRC Inc. and Gyeongsang National University (GNU afterwards) from the year 2014, GNU survived through the fierce competition 5:1 to be finally nominated as an educational institute with its Mechanical Engineering specialties in the Southeastern area for ASEAN talented students according to the officials' account.

Composed of six-week long education programs in the field of theory, field practice, and Korean culture experience, the program is additionally expected to provide Korean enterprises in each Asian country with sound human foundations in a direct or indirect sense together with the purpose of promoting international friendship.

As 24 entrants to the program are to be selected in the area of Mechanical Engineering from 7 Asian countries including Vietnam, Indonesia, Malaysia, and Thailand, the theoretical and applicative educations will be delivered mainly for engineering analysis software developed in Korea and AFDEX as well.

The program for Asian students is quite similar to GISPAM (for more information, please refer to the section of 4.2.7 in Newsletter 2016 Winter). GISPAM is 100% financially sponsored by Mexican government as it is designed for the most qualified Mexican university students in each summer vacation time. This year 20 Mexicans are ready to fly for Korea starting from July 17th for 5 weeks, whose education will be executed by the major control of MFRC Inc. as well.

4. Public notice

4.1 AFDEX presentation at Altair's China rollout events

Shanghai

Changsha

Beijing

Shenzhen

Fig. 4.1 MFRC at Altair's China Rollout events

In the Altair rollout events held from March 17th nationwide in China, which comprise the major cities of Shanghai, Changsha, Beijing, Xian, and Shenzhen, MFRC and its Chinese business partner BRIMET have joined together in broadly presenting AFDEX in the land of the biggest market. The events have been directed toward revealing Altair's new software and its embedded functions to Chinese market, and this time about 450 people are expected to be present searching after the new enhanced features of Altair's software. Meanwhile the two organizations of MFRC and BRIMET are hand in hand to continuously follow the event routes both on the days of April 5th and 8th.

4.2 Chinese Users' Meeting

On the coming Aril 19th BRIMET is going to operate Chinese users' meeting in Shanghai area at Shanghai Holiday Inn Hotel. During the event totally 10 applications and also academic results are ready to be presented including those for the analysis of die structures and advanced technologies in an elastoplastic die deformation involved.

4.3 Exhibition of AFDEX at Hannover Messe 2016

As an exhibitor MFRC is going to participate in the Hannover Messe 2016 from April 25th to April 29th with its booth located at Hall 2, D 57/1. Any entrants to the Messe will be given the training chance of how to use on the spot.

4.4 User's conference

Despite of all the demands for the AFDEX User's Conference, MFCAE 2015 was not held because of the extreme burden from holding the two critical international events, ASPF and GISPAM. Please be kindly advised that this year MFRC is definitely determined to host such public events as fruitfully as possible, while MFCAE 2016 will be held in Jeju Island, Korea at August 18-19, in which the presentations in Korean (not limited to English) are also heartily welcome. We anticipate AFDEX users' more active participations into the Conference. Thank you in advance for your continuous and strong support on the event. You may conveniently reach us when using the e-mail address of mfrc@afdex.com.

Table 4.1 Users' Conference of MFCAE 2016 schedule

Place	Date	Area	Content
Ramada Plaza, Jeju	Aug. 18, Wed ~ Aug. 19, Fri	Jeju	Users' conference

Fig. 4.2 Ramada Plaza hotel in Jeju island

4.5 Participation in the 2016 Spring conference of KSTP

Several members from the AFDEX Development Team are soon to participate in the coming 2016 Spring Conference of Korean Society of Technology of Plasticity with various applicative topics below.

Table 4.2 List of AFDEX papers at the 2016 Spring Conference of KSTP

2016 Spring conference of Korean Society for Technology of Plasticity	
1	Accuracy Consideration in Forging Simulation
2	Elastoplastic Finite Element Analysis of Axis-Symmetric Cold Forging Process with an Elastic Die Deformation
3	Rigid-Viscoplastic Finite Element Analysis of Axi-symmetric Hot Forging Process with an Elastic Die Deformation
4	Elastoplastic Finite Element Analysis of a Bevel Gear in con sideration of an Elastic Die Deformation
5	Rigid-Plastic Finite Element Analysis of Hot Forging Process in a Crankshaft with an Elastic Die Deformation
6	Analysis of the fixed Scroll Die Forging Process in considera -tion of the Elastic Die Deformation
7	Finite Element Modeling of a Hot Aluminum Roll Forging Process with Emphasis on the Grip Role and its Application
8	Finite Element Prediction of Die Temperature in the Long Material Drawing
9	Finite Element Analysis of a Porthole Extrusion Process with an Elastic Die Deformation
10	Elastoplastic Finite Element Modeling of an Ultrasonic Surface Rolling Process under the Plane Strain Condition