A Quarterly Bulletin of Metal Forming Research Laboratory

Bulletin MFRL

School of Mechanical Engineering, Universiti Sains Malaysia

April 2017 Volume 1 Quarter 2 eISSN 2550-2069

Inside the Issue

Recent Publications

1. M. F. Adnan, A. B. Abdullah and Z. Samad, "*Springback Behavior of AA6061 with Non-uniform Thickness Section Using Taguchi Method*", International Journal of Advanced Manufacturing Technology, 89 (5-8), 2017, pp. 2041-2052. (IF 2015 = 1.568 Q2).
2. M. S. M. Zain, A. B. Abdullah and Z. Samad, "*Effect of puncher profile on the precision of punched holes on composite panels*". International Journal of Advanced Manufacturing Technology, 89 (9-12), 2017, pp. 3331-3336. (IF 2015 = 1.568 Q2).

Active Grants

Title: Modeling of Twist Springback Pattern of Aluminum Alloy Strip with Non-Uniform Section.
FRGS (2014 – 2017)
Title: Precision Punching of Composite Panel
RUI (2015 – 2017)

Preface: Editor in Chief

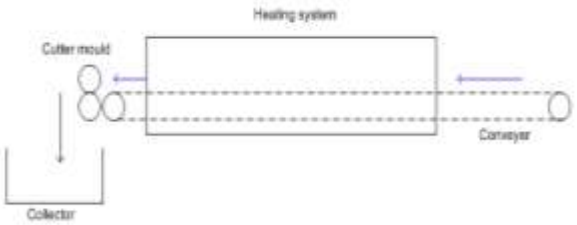
Alhamdulillah, the second edition of the bulletin can be accessed worldwide. The platform is to publicize the Lab activities. Currently, the Metal Forming Research Laboratory (MFRL) is focusing on the following research areas;

1. Tooling design - optimal design of optimal tool and die, for example puncher design for holes punching on composite panel.
2. Geometrical defect using FEA and experimental - deep drawing part defects, springback behavior and die wear.
3. Green manufacturing - automotive part weight reduction via non-uniform thickness and tailor welded blank.

Currently, three PhD and two MSc students is actively doing their research and to date the lab has produced 1 PhD and 2 MSc graduates. Metal Forming Laboratory is currently managed by two key researchers and two technical staff. Within 10 years, various research grants at university and national level have been obtained worth more than RM750,000.00 and published more than 150 research articles indexed in various national and international level. Recent update about the lab can be find at http://metalforming.usm.my.

PPRN Project

PPRN is a Private-Public Research Network, an initiative by Ministry of Higher Education to increase productivity and strengthen Malaysian economic development through demand-driven innovation programs. Our group successfully secures a project with title **Process Improvement for the Production of Spring Roll Seaweed Snack**. The project begins in September 2016 and ends by March 2017. The project objective is to design and fabricate an automatic machine to dry and cut seaweed efficiently.



The general concept of the machine

The fabricated machine

Research Summary 1

Name: Muhammad Nazmi Nashrudin (MSc)
Title: Non-Uniform Section and Effect to the Twist Springback Pattern.

Twist springback is one of main types of springback that can be found in twist forming process. Twist springback occurs when the twisted part tends to return to its original shape after unloading. The main aim of this study is to investigate the springback pattern in the twist forming process of a non-uniform section. Optimization of the process and design parameters to the twist springback will also be explored. This study is divided into two simulation and experimental methods. The material studied is Aluminium AA6061-T6. There are five types of profile will be studied i.e. plane, tapered, concave, convex and stepped. The result of this research can be used to reduce the twist springback effect of the metal forming in manufacturing industry and at the same time can reduce manufacturing costs.

Research Summary 2

Name: Mohd Safie Abdullah (MSc)
Title: Structural Integrity of Carbon Fiber Reinforcement Polymer (CFRP) by performing ASTM D5961 Procedure C.

The performance of bolted joints in composite materials can be optimized in many ways, including optimization of the joint geometry and optimization of the fiber orientation and stacking sequences. In this investigation, the structural integrity of holes produced by punching method on CFRP is evaluated using the standard ASTM D5961 Procedure C. Mechanical joint efficiency is strongly dependent on the quality of produced holes because a bolted joint reduces the strength of a structure by more than 50% for a single-row joint. To evaluate these materials becomes important to know their mechanical properties, for example, the bearing strength. In this study, specimens were obtained by resin transfer molding (RTM) method. Special rig was designed to hold the specimen during the experiment.

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FREE/OPEN SOURCE COMPUTATIONAL ENGINEERING SOFTWARE: AN ALTERNATIVE FOR THE MANUFACTURING INDUSTRY

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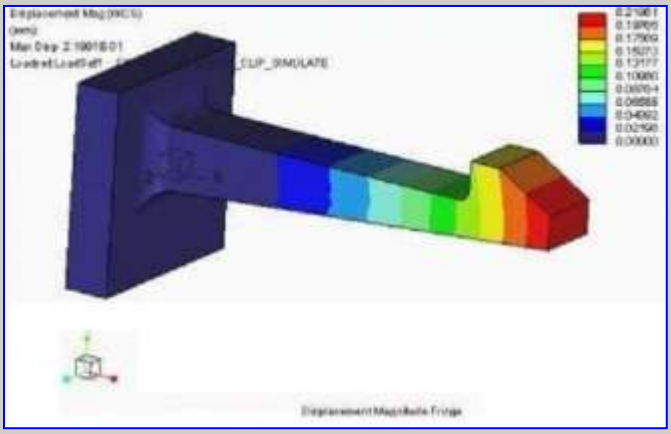
Introduction

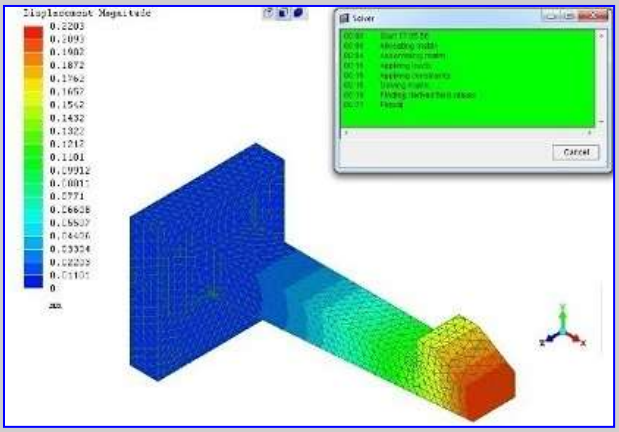
The internet is a vast and rich repository for free/open source computational software environment. Very high quality packages are available for mathematics, numerical analysis, parallel computing, data processing, image visualization, graphics, text preparation and presentation [1]. Generally, open source (OS) software can be roughly defined as a kind of software in which the source code is made available under a copyright license that permits users to use, change, and improve the software, and to redistribute it in modified or unmodified form [2]. Engineering OS software comes from a diversity of sources, developed mostly by universities or higher education centers, research institutions and companies. A common motivation for using OS software is the tremendous savings from license costs, which is a pertinent issue for small companies or financially-constrained organizations. However, the learning curve with OS software may be quite long and requires more versatile IT skills. Nevertheless, the openness of the code in OS software makes it more extendable and customizable, enabling more possibilities to build tailored solutions. Currently, there is a huge number of open source software, and choosing the most suitable package should consider several factors. Among the factors are: **quality** (is the coding of high quality?), **usability** (is the software suitable for the current needs), **extendibility** (can the software be easily enhanced?), **maturity** (is the software mature?), **activity** (is the developer and user base active?), **continuity** (is the background organization committed?), **support** (can the support for the code be purchased?), and **documentation** (is the code well documented?) [3].

Open Source FEA for CAE applications

A side by side comparison of 72 mechanical Finite Element Analysis (FEA) programs can be found at http://feacompare.com/, listing both commercial and free/open source software. A typical question commonly asked of open source software is "are the results generated comparable to those obtained using commercial software?" In this regard, OS software such as Calculix, Elmer, OpenFOAM, Code_Aster and Saturn are being used by big companies for civil, structural and CFD analysis [4]. Figure 1 shows a comparison of the FEA results obtained using a commercial and an OS Software in analysing the loading on a metal hook, showing how close the performance of OS is to commercial software in a simple analysis with regards to stress and displacement. In mechanics and heat transfer, Code_Aster, CalculiX, and Impact are leading open source tools [5]. Code_Aster is a large finite element code which Electricité de France (EDF) has written to solve complex problems in nuclear power. It comes with tools for adaptive remeshing, and is ISO 9001 certified. However, it was noted that this OS software were found to be difficult to install and may not comply with "ready to run off the shelf' requirement that is important in industrial installations [6]. In welding and forming studies, Code_Aster has been used by several researchers for computational evaluations. For example, metallurgical behavior during the laser welding of dual phase steels was evaluated using model Waeckel, inserted into Code_Aster, which simulated the phase transformation in the fusion zone [7]. Similarly, the software was also utilized in the numerical simulation for TIG process of 316L stainless steel [8] [9] [10]. Another use of Code_Aster is on determination of residual stresses and fracture behavior in welded components [11] [12]. In forming processes, Code_Aster was used to calculate the stress distribution in the bending of Aluminium sheet in an Origami-Based Sheet metal folding process [13]. In a simulation of plane strain sheet metal forming, a bending-under-tension model was programmed using Code_Aster with large strain formulation [14].



(a) Commercial Software (CREO Simulate)



(b) Open Source software (Mecway)

Figure 1. Comparison of FEA simulation result (displacement) between commercial software and OS software.

Conclusions

Although open source engineering analysis tools have not been widely deployed, several of them have already reached a point of maturity and usability in industry [5]. Open source software can be an ideal tool for collaborative research to foster innovation and provides the environment to study new areas. It can form the basis for in-house simulation R&D that can be set up with minimal costs. However, critics claim that open source software won't offer sufficient comprehensive solutions for large businesses, would be harder to install and use and has less standardization than commercial software. Moving forward, the role of open source is likely to continue to expand as many OS tools have reached a level of feature completeness and usability that makes them suitable for broader industrial use.

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