Manobalan R, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 10, Issue 5, (Series-III) May 2020, pp. 39-41

RESEARCH ARTICLE OPEN ACCESS

Material Yield Optimisation of Tailored Welded Sheet Metal Blanks Using Cad Automation

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ABSTRACT
In engineering applications, one may encounter complex design situations. Previously, designs were drawn on sheets and manufactured manually using drafting techniques. Things have changed with the introduction of CAD customization and design automation. CAD customization is the development of support tools and technology which drives CAD automation of repetitive tasks in the design process. Design automation is knowledge based engineering approach which logically combines various engineering concepts with real time application study during product development. The use of CAD software allows designers to introduce more details and save a considerable amount of time. For instance, many of the repetitive tasks can be computerized within CAD software. With customization of CAD functions, organizations automate redundant tasks and experience great time savings. CAD customization allows engineers to keep their core focus on product development without having to worry about support functions. The benefits of CAD customization include enhanced productivity, reduced human errors, and systems integration. This paper is intended to create an automated CAD tool to optimize the yield utilization of tailored sheet metal blanks used in automotive and aerospace applications, in particular. Tailored blanks are semi-finished parts, which are typically made from sheets with different alloys, thicknesses, coatings or material properties. After joining, these will be subjected to deep drawing or stamping. Tailor welded blank (TWB) is one of such improvement which have really proved to be a promising to get all primary goals of the stamping industry very effectively. In sheet metal forming operation, the blank is typically supplied in a single piece, usually cut from a larger sheet and has uniform thickness. Especially, car body panels were made up of several smaller BIW components. Each component is formed individually and subsequently welded together to create the desired body panel. This approach incorporates high tooling, long lead time, laborious efforts & certainly high material costs. Moreover, this approach also contributes to the dimensional inaccuracy in the assembly process. Therefore, it is attractive to form the body panels in a single stamping by using Tailored Blanks, to incorporate various advantages in single sheet.

Keywords: Computer Aided Design, Automation, Tailored Welded Blank, Body-in-White, Automotive

Date of Submission: 13-05-2020 Date of Acceptance: 26-05-2020

I. INTRODUCTION

Due to legal and social changes pushed by the society, reducing carbon dioxide emissions and resource consumption play a decisive role in industrial research and development. Focusing on more efficient products and processes recently is seen as a key capability recently. In Particular the automotive industry was affected by these radical changing. This calls for disrupting innovations and adapting new technologies becomes inevitable in current scenario. In any automotive, the Body-in white (BIW) is the major weight contributing system ranges about 40% to 45% of total weight of an automotive is governed by the BIW system. Hence to reduce the weight of a BIW is very critical to reduce CO2 emissions and improved fuel efficiency to meet the modern mobility regulations to ensure Sustainable Development Goals (SDG) are achieved. Though enormous technologies and concepts are being evaluated to reduce the weight of an automotive BIW, using dissimilar thickness materials to for Body panels is one of the efficient ways to reduce the weight of the overall BIW.

II. TAILORED WELDED BLANKS

Tailor Welded Blanks are made from individual sheets of steel of different thickness, strength and coating which are joined together by laser welding. This manufacturing process allows for flexible part design and ensures the right material is used in the right place. Thicker or higher-strength material can be used in highly stressed areas while thinner sheets or deep drawing grades can be used in others. Expensive materials are only used where they are needed. This targeted approach has benefits including: Cost Reduction, By using expensive materials only where necessary, parts can be produced at a reduced cost. Reduced Weight, By utilizing the appropriate material in the appropriate area, part weight can be reduced. Increased Strength, Higher strength material can be used in highly stressed areas, increasing structural and crash performance.

The tailored welded sheet metal blank yield optimization is calculated based on the developed surface of the sheet metal parts from the CAD packages. The Sheet metal part is designed in CATIA V5 and saved in .IGES format. The CAD data in .IGES format is loaded to another software package called FTI – Form suite to create the blank layout for the given CAD data uploaded. This Blank layout is then exported to CATIA V5 to automate the blank yield utilization using CATIA Macro automation technique written in software scripting methodology called .CAT script. This .CAT script is an in-built scripting platform to automate the repetitive tasks in CATIA V5.

III. DESIGN INNOVATIONS

Since the 1980's, a number of automakers have, in close cooperation with material suppliers, produced aluminum intensive vehicles using two design approaches. First, the conventional steel unibody designs have been converted into all-aluminum body-in-whites through part-to-part substitutions. The stamped aluminum parts, although thicker than their steel counterparts, can yield substantial weight savings. An example of this concept is the Honda Acura NSX sportscar in which the weight of the aluminum BIW is 210 kg or 40% lighter than its theoretical steel-sheet equivalent. More recently, Ford has developed a prototype of a medium-sized vehicle with a stamped aluminum unibody, the P2000. Due to the extensive use of aluminum and other lightweight materials in the P2000, its total weight is approximately 900 kg or about 40% less compared to the 1997 Ford Taurus and its weight of 1500 kg. This innovative aluminum design is eventually targeted for high volume production, although the current prototype is estimated to be thousands of dollars more expensive to manufacture than the Ford Taurus. Another design approach for aluminum is the space frame technology, which exploits the excellent formability of aluminum, enabling better utilization of the potentials of aluminum in light weighting of the BIW. Contrary to the unibody with all-stamped parts, the predominant load-bearing structure in aluminum space frame designs consists of extrusions joined together by cast nodes. Stampings are used to complete the design, forming the floor and exterior panels. The space frame concept yields BIW weights that are in the order of 130 to 175 kg (285 to 385 lbs.). The different production vehicles and prototypes mentioned above have demonstrated the capabilities of the intensive use of aluminum in the BIW light weighting. However, this usually results in a cost penalty because of the higher material and processing costs compared to all-steel bodies. Despite the generally higher manufacturing costs of aluminum designs, the difference in the raw material cost is still the main reason why the use of aluminum in holistic BIW designs has so far been limited only to niche market, low-volume vehicles.

IV. METHODOLOGY

The .CAT script is written in such a way that, the un blanked developed surface of the CAD data to be called in the CATIA V5 GSD workbench. Based on the developed surface obtained from FTI package. This developed surface is used to create the rectangular sheets with required manufacturing allowances to shear the blank from simple rectangular sheets as per industry standards with permissible allowances. The un blank CAD profile is rotated with an automated script for each angle of rotation from 0 deg to 90 deg with an increment of 1 deg for each rotation. The calculation of material yield utilization is as follows.

Yield Optimization calculation:

An illustration is shown to demonstrate how this optimization works. Following are the parameters automated in .CAT Script to obtain the results in Excel format are as follows;

Area of the part (developed surface of sheet metal part) =

Area of the sheet metal blank =

Length wise clearance to blank the developed surface =

Width wise clearance to blank the developed surface =

Material Yield (in %) = (Area of the sheet metal blank – Area of the part) ÷ Area of the sheet metal blank * 100 %

The above yield percentage for each angle of rotation of blanked part is automatically generated with the help of the pre written .CAT Script.

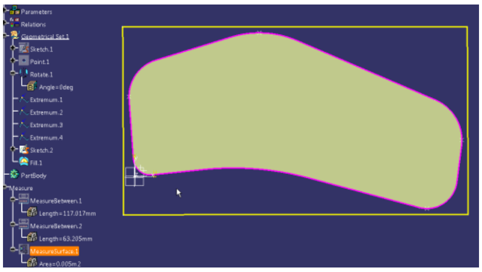

Fig 1; CAD profile for Blank layout and developed surface of sheet metal part

The sheet metal tailored welded blanks and The analyses of different welding processes indicated that the cost effective welding system choice varies with blank complexity. Based on the sensitivity analyses, the loading of blanks seemed to be the main factor causing the variations in the welding costs. Also, the comparisons suggest that the most promising welding system for processing blanks with multiple, non-parallel welds is the two-axis CO 2 laser. The mash seam welder seemed to be the most favorable system for parts with short, parallel welds.

A schematic comparison of Tailored welded blanks over conventional steel design is shown in below Fig 2.

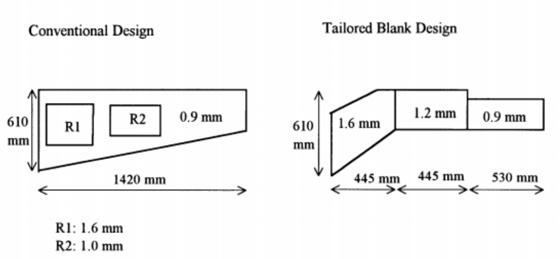

Fig 2; Schematic comparison of Conventional Sheet metal design over Tailored welded Blank design

V. CONCLUSION

The objective of this study was to contrast the economic feasibility of tailor welded blank technology to conventional part designs. This was achieved by analyzing the manufacturing costs of various body-in-white parts utilizing the developed tailored blanking cost model. The focus was on examining the cost effect of alternative materials (steel and aluminum), blank complexity (number and position of welds), and welding system options (one-axis CO 2 laser, two-axis CO 2 laser, and mash seam welding). The case studies of alternative steel and aluminum designs suggested that parts integration can reduce the weight and improve material utilization over conventional body-in-white part designs. In order to achieve these benefits, however, each tailored blank design has to be highly scrutinized before implementation. If the design specifications are not carefully considered, tailor welded blanks may have the risk of increasing the part weight.

REFERENCES

Books:

[1]. VB scripting for CATIA V5, Emmet Ross (Amazon Kindle, 2015)

Theses:

[2]. Anna M. Lokka, An Economic Evaluation of Tailor Welded Blanks in Automotive Applications Masters diss., Massachusetts Institute of Technology, Cambridge, MA,.