Journal of Achievements in Materials and Manufacturing Engineering

VOLUME 23
ISSUE 2
August
2007

Effect of different extrusion temperature and speed on extrusion welds

S. Bingöl*, M.S. Keskin
Mechanical Engineering Department, Dicle University, 21280 Diyarbakir, Turkey
* Corresponding author: E-mail address: sbingol@dicle.edu.tr

Received 18.04.2007; published in revised form 01.08.2007

Properties

ABSTRACT

Purpose: In this study, it is aimed to investigate the structure of seam weld and transverse weld sections comparatively. To achieve this, it is studied on an extrusion profile type which has seam weld and transverse weld regions.

Design/methodology/approach: Producing extrusion profile has been performed by a press, which has a capacity of 1460 tones, in a real producing and carried out by changing the exit temperature and ram speed, which are the important parameters. Exit temperature T_E, is chosen as 440, 475, 500, 520 and 560 °C. Extrusion speed is also taken in the base of ram speed V_R, and production is carried out at the speeds of 2, 4, 6, 10 and 15 mm/s. Therefore the effects of extrusion parameters on macrostructure properties have been investigated.

Findings: It is seen clearly that some differences are occurred from the viewpoint of structural features between the regions, when the experimental results are observed without regarding the extrusion parameters. In addition, it was observed commonly the structure of the material had a change through re-crystallization with increasing temperatures. This situation decreases the significance of seam weld regions. But insignificancy of seam weld region is designed as possible as can be from the viewpoint of decorative. However, when the macro structural figures have been investigated as the ram speed increases more significance on seam welds occurs.

Research limitations/implications: Also some macrostructural differences in extrusion welds may occur for between having the other important extrusion parameters such as pressure and extrusion ratio. Therefore, effect of the other parameters can be investigated in future.

Practical implications: In application, extrusion welds occur on both solid and hollow profiles. Moreover, extrusion temperature and speed often changes. This study shows that these parameters effect to macrostructure of extrusion welds.

Originality/value: In this study, it is seen that different macrostructural properties take place due to the process parameters variations and natural of extrusion method in the extrusion production.

Keywords: Mechanical properties; Extrusion welds; Extrusion temperature; Extrusion speed; Seam weld; Transverse weld

1. Introduction

In application, aluminum profiles are frequently produced [1-3]. Producing of the profiles which have hollows by the porthole dies, containing mandrel and welding chamber [4-11]. Hollow profiles production can be summarized briefly in following;

Billet in the container is pressed toward the die by the stam, fairly pressed billet to surface of the die, is divided into metal streams by the die ports. Divided metal streams exit from the die after joining in the welding chamber which is behind of the mandrel. These joins are called as seam welds [11, 12]. Therefore, profile production which has longitudinal welds is implemented even for only a billet stroke. Also being extruded of consecutive billets, the joint occurs among the profiles resulting from each extrusion stroke. This joint is called as transverse weld [13].

In literature, Akaret [14] concluded that the weakest link of the extrusion weld is the transverse weld regions. Material flow in extrusion dies and solid state bonding immediately after the mandrel supports were well investigated by Valberg [15]. To determine the mechanical properties of seam weld region, tensile specimens were prepared with the weld located at 0°, 45° and 90° to the tensile axis by Loukus *et al* [16]. The specimens with 45°-weld exhibited the lowest tensile strength, followed by 90°-weld, no weld and 0°-weld specimens.

2. Experimental works

The profiles for investigations, containing the transverse weld, used in the study, are obtained from the real manufacturing process. However, the company has not allowed publishing dimensions of the profile section.

2.1. Material

The AA6063 alloy type was used for the experiments, which is commonly used and the preferred one, among the aluminum alloys. This alloy makes it possible to obtain profiles with complex geometry as its properties are very advantageous for plastic forming.

2.2. Production

Production of experimental profile has been carried out in the MEIUREY modeled press, which has the capacity of 1460 tones.

Table 1.
The composition of the solution for macrostructure etching

HCI (concentrate)	HNO_3 (concentrate)	HF (%48)	Water
60	30	5	5

2.3. Macrostructure Tab

For the etching process of macro structure specimens, parallel surfaces have been provided between cross sectional surfaces of specimens by planer the surfaces before specimens are subjected to etched process. Implementing this process is important for equal abrasion at all sectional surface regions.

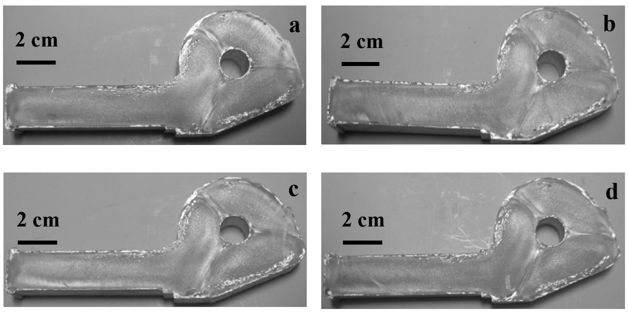

Fig. 1. The specimens with only seam welds (without transverse weld): a)T_B=430°C, V_R=10mm/s, T_E=475°C; b)T_B=430°C, V_R=10mm/s, T_E=440°C; c)T_B=450°C, V_R=15mm/s, T_E=475°C; d)T_B=430°C, V_R=15 mm/s, T_E=475°C

The specimens are consecutively subjected to 120, 180, 240, 600, 1200 grit abrasives for Poulton [17] solution (Table 1), which has given the best results among several etched, with 10 seconds period. The etching process was gone on till the best view has been obtained. Generally, this time has been between 30 and 60 seconds.

3. Experimental results and discussion

When the macrostructures and their parameters in Fig. 1 is examined, it is seen that there is a little difference among parameter values. The billet temperatures, profile exit temperatures, and ram speeds are at 430 °C, and 450 °C, at 440 °C, and 475 °C, and at 10, and 15 mm/s respectively. These temperature values are low temperatures for the extrusion process. Also the ram speeds have high values for these profiles, which has extrusion rate (A_O/A_1) as 5. Thus it is has been seen that there aren't any significant differences for the created macro structures. Where, A_O is billet section area, and A_1 is profile section area.

As the macro structural pictures of the mentioned figures are examined, it is seen that an important component which attracts the attention, is that the seam weld zones are really distinctive. To understand the reason of this situation, the production phases of an empty profile with porthole die should be thought. In the extrusion process, billet is divided to various metal streams by the die ports and at least it becomes a profile by being jointed in the welding chamber, behind the mandrel support. Also the effect of the speed differences of the joining material in the welding chamber on the seam weld should be understood. The extrusion process starts in a specific ram speed and at the beginning the billet has this ram speed. By dividing the billet to various metal streams by the die ports, each metal stream has a different and a new speed value. The speed in here is more than the ram speed, of which the billet has at the beginning. The metal streams with different speeds, move to the welding chamber as narrowing in the width, and increase in their speed. Here, they are welded in a new volume and they enter to the die bearing. The speeds in the welding chamber and also in the die bearing are new and different. Finally, the material which passes through the die bearing comes out from the die, as being a profile and with a new speed value (this speed is named as the profile exit speed).

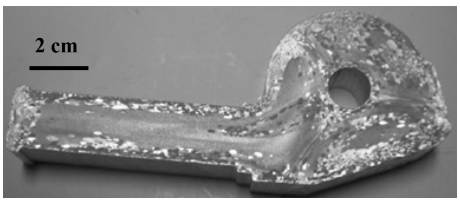

Fig. 2. The specimen with both seam welds and transverse weld; T_B=470°C, V_R=10 mm/s, T_E=500°C

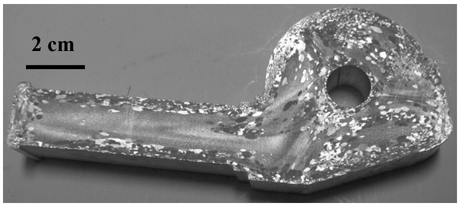

Fig. 3. The specimen with both seam welds and transverse weld; T_B=490°C, V_R=10 mm/s, T_E=500°C

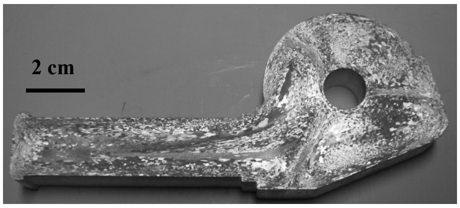

Fig. 4. The specimen with both seam welds and transverse weld; T_B=490°C, V_R=15 mm/s, T_E=520°C

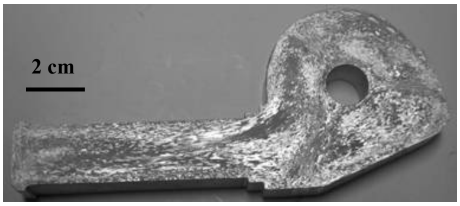

Fig. 5. The specimen with both seam welds and transverse weld, T_B=490°C, V_R=6 mm/s, T_E=520°C

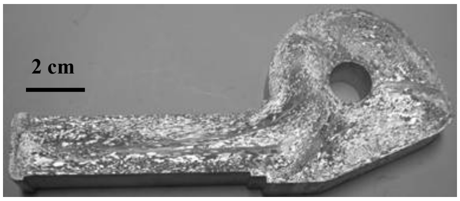

Fig. 6. The specimen with both seam welds and transverse weld; T_B =510°C, V_R=15 mm/s, T_E=520°C

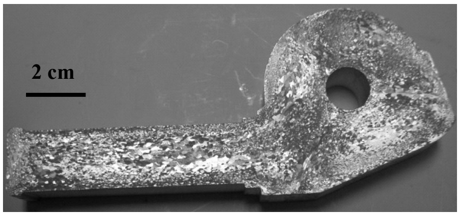

Fig. 7. The specimen with both seam welds and transverse weld; T_B =510°C, V_R=4 mm/s, T_E=560°C

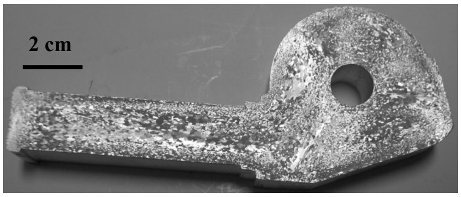

Fig. 8. The specimen with both seam welds and transverse weld; T_B=510°C, V_R=10 mm/s, T_E=560°C.

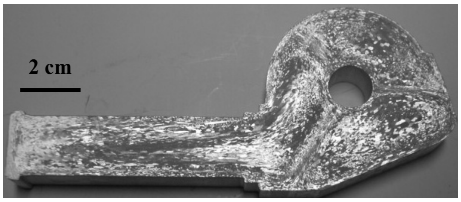

Fig. 9. The specimen with both seam welds and transverse weld; T_B=490°C, V_R=10 mm/s, T_E=520°C

After explaining the forming process of the seam weld, and the speed case of the extrusion process, it would be easier to explain the effects of the extrusion speed on seam weld.

- If the ram speed is high, the speed of metal streams of the ports will also be high.
- If the speeds of the metal streams are high, the speeds of the welding metal streams in the welding chamber will also be high.

This situation decreases the time that the metal streams will have to be welded. Therefore, the welding phenomena which has to become stable in the die bearing, results by not being realized as wished because of the high speed, and the decrease of the time. That's why, to work with high extrusion speeds, badly effects the seam welds.

Another reason of the seam welds differences, which are presented in these figures, is the billet temperature T_B and the profile exit temperature T_E are low. The fact that the temperature is low (with the high speed) has played a decreasing role in the engagement of the welding surfaces.

When the Figs. 2 and 3 are investigated, it is seen that the billet temperature values are close to each others, and these values are 470 °C and 490 °C in the situation of same extrusion speeds ant exit temperature. The macro structural pictures that are shown in these figures have some structural differences Fig. 1 but they don't have serious distinctive structural differences among each other.

It is observed in Figs. 2 and 3 that the existence of connection zones becomes a matter of interest. These specimens are taken from the near zones in spite of being taken from the joint of formed extruded billets they have transverse weld. The structures of the transverse weld zones are similar to each other and there is no serious difference between them.

In Figs. 4 and 5, structures with coarse grain are seen. There is transverse weld in each figure. Also the Fig. 3 has the transverse weld but it is small compared to the welding zones of the Figs. 4 and 5, which is a little smaller than the welding zone of the Fig. 4

but it is more distinctive than the Fig. 5. The reason for being less significant of transverse weld in Fig. 3, than of the Fig. 4, is that its billet temperature has a higher value. On the other hand the distinction of the transverse weld of the Fig. 6 from the Fig. 5, is because of the higher difference in their speed value. Even if the billet temperature is higher when compared to the Fig 5, its welding zones are more distinctive.

In Fig. 7, there is a structure with coarse grain which covers the entire structure. When the billet temperature and the profile exit temperature are tested, it is seen that the two of them have the highest billet temperature values. Therefore, low ram speed has decreased the distinction of the seam weld zones.

Also a structure with coarse grain is seen in Fig 8. As the shape of this structure is compared with Fig. 7, it is seen that the seam weld are less distinctive. The reason of this is that the ram speed in Fig. 7 is higher than in Fig. 8.

When the values of the parameters of the Fig. 9 are examined, it is seen that it has the same value of ram speed with the Fig. 8. But, the billet temperature and the profile exit temperature of the Fig. 8 have lower values. When the structural differences between the two figures are examined, it is seen that the welding zones of the Fig. 9 are more distinctive. This situation shows that the profile center didn't reach the necessary temperature level.

4. Conclusions

As the results of the macro structural specimens are examined by considering the production parameters, the following observational conclusions are obtained:

- In the situation of the billet temperature (T_B) and the profile temperature (T_E) increase, in one hand a structure with coarse grain is occurred and on the other hand the distinction of the welding zones is decreased.
- While the ram speed (V_R) increases, a structure with no coarse grain is occurred, and the distinction of the welding zones is increased.

Acknowledgements

This study has been supported by Sistem Aluminum Company in Turkey.

References

[1] S. Karabay, M. Zeren, M. Yilmaz, Investigation extrusion ratio effect on mechanical behaviour of extruded alloy AA-6101 from the billets homogenised-rapid quenched and as-cast conditions, Journal of Materials Processing Technology, 160 (2005) 138-147.

[2] P.K. Saha, Aluminium Ekstrüzyon Technology, ASM International, The Material International Society (2000).

[3] S. Kalpakjian, Manufacturing Process for Engineering Materials, 2nd edition, Illinois of Technology (1991) 374-376.

[4] W. Xianghong, Z. G. L. Yiguo and M. Xinwu, Numerical simulation and die structure optimization of an aluminum rectangular hollow pipe extrusion process, Materials Science and Engineering A 435-436 (2006) 266-274.

[5] U. Chakkingal, W. Z. Misiolek, Welding Phenomena in Extruded Aluminum Hollow Profiles," Automotive Alloys II, The Minerals, Metals & Materials Society (1998) 195-205.

[6] I. Duplancic, J. Prgin, Determination of Parameters Required for Joining Process in Hollow Dies, Proceedings of the 6th International Aluminum Extrusion Technology Seminar Papers, ET'96, Chicago, Vol. 2 1996 225-230.

[7] J. X. Xie, T Murakami, K. Ikeda, H. Tahakashi, Experimental Simulation of Metal Flow in Porthole Die Extrusion, Journal of Materials Processing Technology 49 (1995) 1-11

[8] K.J. Kim, C.H. Lee, D.Y. Yang, Investigation into the improvement of welding strength in three-dimensional extrusion of tubes using porthole dies, Journal of Materials Processing Technology 130-131 (2002) 426-431.

[9] H.H. Jo, C.S. Jeong, S.K. Lee, B.M. Kim, Determination of welding pressure in the non-steady-state porthole die extrusion of improved Al7003 hollow section tubes, Journal of Materials Processing Technology 139 (2003) 428-433.

[10] J.M. Lee, B.M. Kim. C.G. Kang, Effects of chamber shapes of porthole die on elastic deformation and extrusion process in condenser tube extrusion, Materials&Design 26 (2005) 327-336.

[11] A.R. Bandar, K. Lorcharoensery, W.Z. Misiolek, Three-dimensional material flow analysis of asymmetric hollow extrusions, Journal of Materials Processing Technology 80 (1998) 657-664

[12] Y.T. Kim, K. Ikeda, T. Murakami, Metal flow in porthole die extrusion of aluminum, Journal of Materials Processing Technology 121 (2002) 107-115.

[13] I.J. Veikko, C.W. Jowett, R.F. Dickson, Transverse Weld Defects," Proceedings of the 6th International Aluminum Extrusion Technology Seminar Papers, ET'96, Chicago, Vol. 2 1996 89-94

[14] R. Akaret, Extrusion Welds – Quality Aspects are Now Center Stage, Proceedings of the 5th International Aluminum Extrusion Technology Seminar Papers, ET'92, Chicago, Vol. 1 1992 319-336.

[15] H. Valberg, Extrusion Welding in Porthole Die Extrusion, Proceedings of the 6th International Aluminum Extrusion Technology Seminar Papers, ET'96, Chicago, Vol. 2 1996, 213-224.

[16] A. Loukus, G. Subhash, M. Imaninejad, Mechanical Properties and microstructural characterization of extrusion welds in AA6082-T4, Journal of Materials Science 39 (2004) 6561-6569.

[17] ASM Metals Handbook, Metallographic Technique for Aluminum Alloys, Vol.7, 120-124.