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A quality problem in seam welds in aluminum extrusion

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ABSTRACT

Purpose: Seam welds occur during the hollow profile extrusion; the billet's material is divided into separate metal streams by the bridges of the die which support a mandrel, and then these metal streams are welded in welding chamber behind the bridges. When the desired conditions have not been provided, the required quality in seam welds may not occur. One of the possible reasons for this situation is a poor metal feed. In this study, an insufficient pressure problem occurring in seam welds on an aluminum extrusion profile section is investigated.

Design/methodology/approach: The study was realized on a hollow extrusion profile type which has seam weld zones. The experimental profile was produced by a real extrusion press which has a capacity of 1460 tones.

Findings: The poor metal feed occurring on specimen is shown by microstructural pictures. Microstructure of the main region has a homogenous appearance. In the microstructure, containing seam weld region, only a slight change was observed in seam weld region. However, there was no significant change in near of seam weld regions. This points out that there has been no metallurgical problem. Therefore, the problem is an insufficient pressure problem and this caused poor metal feeding. In the other hand, micro hardness tests are realized on seam weld region, main region and defective region's surround of specimen's section. After the micro hardness tests important differences are shown among these regions' strength. Hardness values of seam weld region were lower than the main material's hardness values, but higher than the defective region's.

Practical implications: In application, seam welds occur on hollow profiles produced by aluminum extrusion.

Originality/value: As a result, this study shows a quality problem in seam welds in aluminum extrusion.

Keywords: Metallic alloys; Seam weld; Aluminum; Extrusion; Porthole die; Welding chamber

MATERIALS

1. Introduction

Seam welds [1-4] are occurred during the hollow profile extrusion [5-7]; the billet's material is divided into separate metal streams by the bridges of the die which support a mandrel, and then these metal streams are welded in welding chamber behind the bridges [8-14].

Sufficient width of welding chamber should be necessary for supplying the exact metal feeding and optimum pressure conditions in the welding chamber [6, 9, 10]. However, welding chamber should be narrow for optimum die strength [15, 16]. The dimensions of the welding chamber should be prepared proper to these situations. Moreover, the study, prepared by Duplancic and Pirgin [7] has shown that mechanical properties of seam welds heal by increasing the pressure of welding chamber.

This study describes a quality problem in seam weld in a hollow aluminum extrusion profile.

2. Experimental works

2.1. Material

For experimental study, AA6063 alloy type among the aluminum alloys, which is common preferred one, is used. AA6063 allows producing the profiles which have complex geometry due to the fact that it can get good plastic shape.

2.2. Production

Production of experimental profile has been carried out in the MEIUREY modeled press, which has the capacity of 1460 tones. The production parameters values during the experimental study are shown in Table 1.

2.3. Micro structures tests

At first, cutting process of specimens is implemented with Struers SECOTOM-19 device sensitively (without deformation of the section, which will be investigated). Specimens which have been cut, was done meshing process. For meshing process was used Struers ROTOPOL-25 device. Holding the meshed specimens and applying force to them is implemented with Struers ROTOFORCE-4 device. Meshing process is implemented by 120, 180, 240, 600, 1200, 2500 and 4000 grit abrasives under 20N strength. After meshing process was completed, the specimens were polished by 3μm MD Mol abrasive with 1μm diamond paste. For finally polishing, colloidal silica was used. After this process, the specimens were etched by Barker solution for 100 seconds and investigated under polarize optic with ZEISS microscope.

2.4. Hardness tests

For micro hardness measuring is used HVS-1000 device. Loading, and pressing periods are choose as 50kg, and 10 seconds respectively.

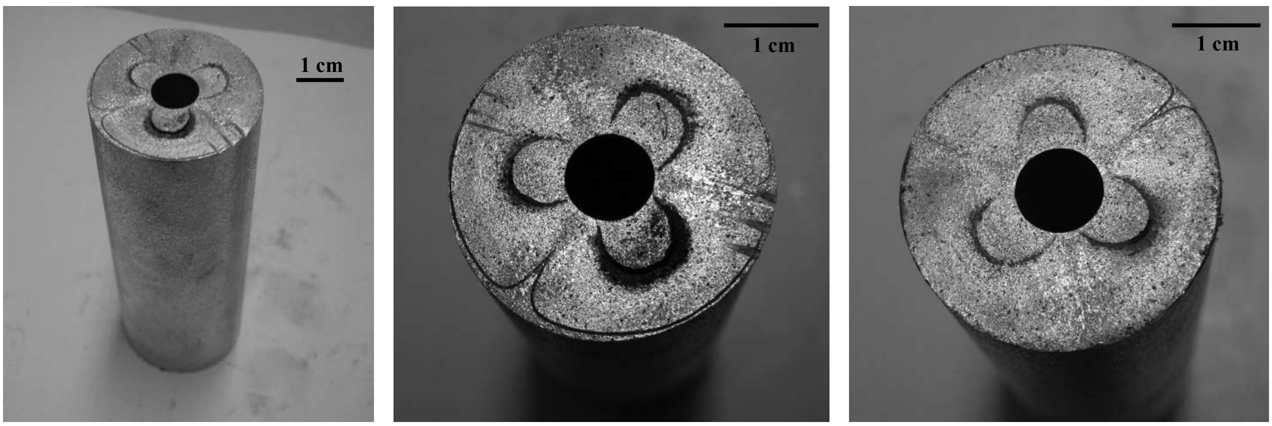
3. Results

Fig. 1a shows extruded experimental profile. Figs. 1b and 1c show seam weld regions and partially-filled defective region in specimen section. Figs. 2 and 3 show microstructures belonging precipitates. There is also the defective region in Fig. 2. Fig. 3 shows precipitates in microstructure of the normal structure. Fig. 4 shows microstructures investigated under polarize optic. From these microstructures, Fig. 4a shows grain structure of main region, and Fig. 4b shows seam weld region and grain structure of surrounding region.

In Fig. 5, micro hardness values belonging main region, seam weld region and surround of defective region were shown on the graphic. When micro hardness values were examined, it is seen that seam weld region's hardness strength is less than the main region. On the other hand, micro hardness values of the surround of defective region were observed as very low.

Table 1.
Production parameters used in experimental study

Extrusion ratio	Ram velocity (mm/s)	Billet temperature (^oC)	Exit temperature (^oC)	Die temperature (^oC)	Container temperature (^oC)
16	14	440	460	430	430



a b c

Fig. 1. a) Extruded experimental profile, b-c) seam weld regions and partially-filled defective region in specimen section

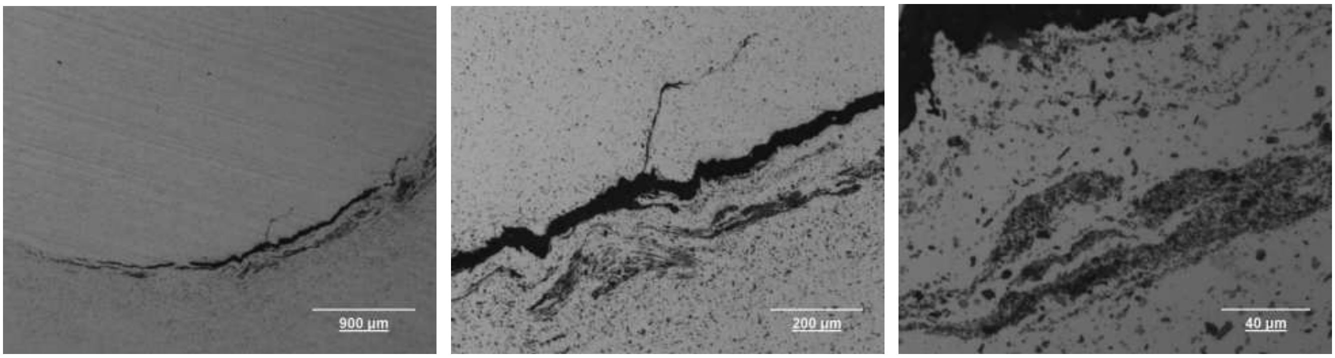


Fig. 2. Precipitates in microstructures of the defective region with different zooms

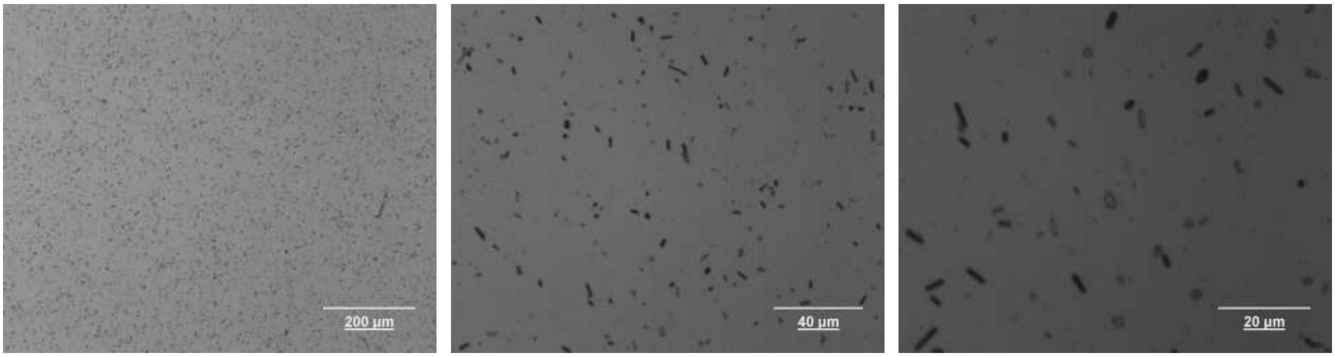


Fig. 3. Precipitates in microstructures of the normal region with different zooms

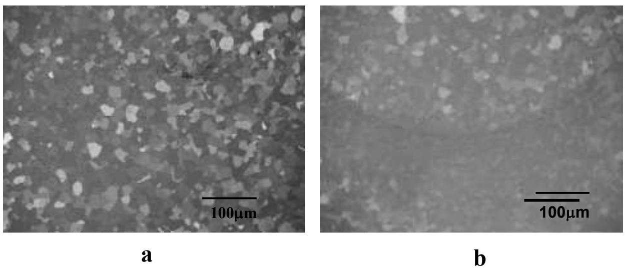


Fig. 4. The grain structures which investigated under polarize optic; a) normal region, b) seam weld region

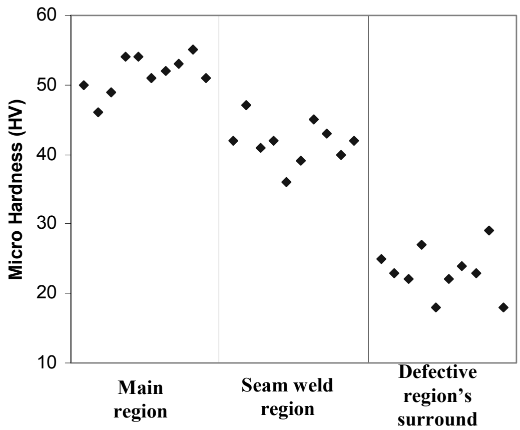


Fig. 5. Micro hardness values belonging main region, seam weld region and surround of defective region

4. Discussion

Poor metal feed in seam weld and defective region shows that the necessary pressure for a good welding was not occurred. Not filling the die gap completely with billet material during the extrusion process might be the reason of this. Moreover, when the reduction of area from the gap to the web is insufficiently small, the metal pressure is not high enough to fill the gap completely. According to Akaret [16], these unfavorable conditions are more likely to occur at higher speeds, possibly due to an increase of the temperature difference between areas of fast and slow metal flow. If the production conditions in this experiment are observed, then it will be understood that the ram speed is high.

On the other hand, when microstructures are examined, no serious change inside the structure is detected except the region where metal feeding was insufficient. Microstructure of the main region has a homogenous appearance. In the microstructure, containing seam weld region, only a slight change was observed in seam weld region. However, there was no significant change in other regions. This points out that there has been no metallurgical problem. Therefore, the problem is an insufficient pressure problem and this caused poor metal feeding. Poor metal feeding has caused cavity in profile section, leading to the defective. Also, micro hardness in surround of the defective region was very low. Poor metal feeding was also encountered in seam weld region. Hardness values of seam weld region were lower than the main material's hardness values, but higher than the defective region's.

5. Conclusions

Following results were obtained as a result of examining the effects of poor metal feeding, caused by low pressure, on section of a hollow profile produced from a porthole die:

- When the precipitates in microstructures were examined, no differences were observed in terms of precipitates between the main region and seam weld region.
- No significant differences were observed in terms of grain size between the main region and seam weld region.
- The surround of defective region, where there was poor metal feed, has presented the lowest micro hardness strength.
- Micro hardness strength of seam weld region was higher than the defective region, but lower than the main region.

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