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Comparison of the Effects of Shot Blasting and Sandblasting Processes on the Strength of the Aluminum Adhesive Bonded Joints

A. Safari, M. Farahani*

Mechanical Engineering department, College of Engineering, University of Tehran, Tehran, Iran

ABSTRACT: In this paper, the influences of surface roughness on the strength of the single lap adhesive joints for the prepared adherent with shot blasting and sandblasting processes were examined. Sheets from 2024-T3 aluminum alloy were cut into pieces and then shot blasted at four different durations and sandblasted with four different pressures. Prepared aluminum specimens were jointed using two different adhesives, two-component Araldite 2015 with high viscosity and epoxy HPL1012/HPH112 with low viscosity. The effects of process parameters on the surface roughness of the adherent and ultimate shear strength of the joint were investigated using design of experiments technique. Tensile test was used to determine the ultimate strength of the joints. The obtained results were presented comparatively. It was shown that by increasing the surface roughness of shot blasted and sandblasted samples, the ultimate shear strength of the joints increases continuously. The optimum surface treatment for ductile and brittle adhesives was similar that shown no relation of this optimum roughness to adhesive type in the prepared samples with sandblast and shut blast processes. The highest ultimate shear strength was obtained for the sandblasted specimens at maximum pressure of 6 bar with 0.6 micrometers of surface roughness.

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1- Introduction

The capability to connect and assemble is one of the most important issues in manufacturing and production [1]. Surface roughness is an important factor that influencing the mechanical properties of a joint. Surface modification and preparation and its effects are of attention in adhesive joints [2].

Different methods are available for connecting homogenous structures. Adhesive joints are employed in various structures [1]. Adhesive joints advantageous including: high shear strength, reduced stress concentration, distribution of forces all over the joint, adequate fatigue strength, reduced structural weight, corrosion resistance and higher efficiency. The weakest points in structures are the joints [3].

There are some limitations in the adhesive joints, one being a dependency of strength on the quality of joint surfaces. The adhesive joint strength depends on the surface preparation, the environmental conditions, loading and joint design [4]. Mechanical surface preparations have been proposed for strengthening composite and metal joints. Using of various preparation processes is effective for improving the strength of the adhesive joints [5].

The effect of surface preparation on the joint strength has not been studied adequately and no comparison has been made between adhesive types and surface preparation methods. Surface finish methods, including sandblasting and shot blasting were used in this research. Shear-tension tests and roughness measurement tests were also performed to examine the effect of surface preparation process on the surface roughness and consequently single-lap adhesive joint strength.

Corresponding author, E-mail: mrfarahani@ut.ac.ir

2- Methodology

2024-T3 aluminum alloy, Araldite 2015 adhesive with high viscosity and HPL1012/HPH112 epoxy adhesive with low viscosity were used in this research.

According to ASTM D 5868 standard, aluminum sheets with 2 mm thickness are cut into 102 mm×25 mm pieces. The overlap length is considered equal to 30 mm with adhesive thickness equal to 0.75 mm.

Shot blasting was carried out for 120 s, 160 s, 200 s and 240 s. Sandblasting process was performed under 1, 2, 3, and 6 bar pressure. A survey of the literature showed that the pressure is the most effective parameter in sandblasting [6,7].

The roughness of the prepared surfaces were measured by Hommelwerke TK300. Roughness values (*Ra*) were obtained in terms of micrometers. Roughness measurement was performed at 0.15 mm/s along 10 mm of the specimens. The specimens were bound using Araldite 2015 and HPL1012/HPH112 adhesives. Tensile test was performed at 0.5 mm/s using Shijin WDW-300E tensile test machine.

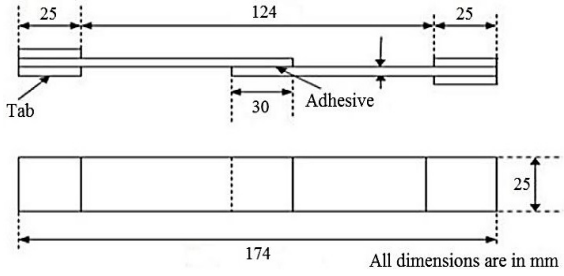

Fig.1. Sample dimensions according to ASTM D 5868

3- Results and Discussion

Higher numbers of pits are created on the surface at higher roughness levels, which result in a better penetration of adhesive. Consequently, the contact area between the joining parts was increased and the adhesive joint strength was improved. The results can be summarized in the following graphs.

Figs.2 and 3 represent the ultimate shear strength of the joint surface versus the roughness of sandblasted samples. Two different adhesive types, Araldite 2015 adhesive and epoxy adhesive were used. Comparison between the ultimate shear strength-surface roughnesses of sandblasting samples was shown in Fig.4.

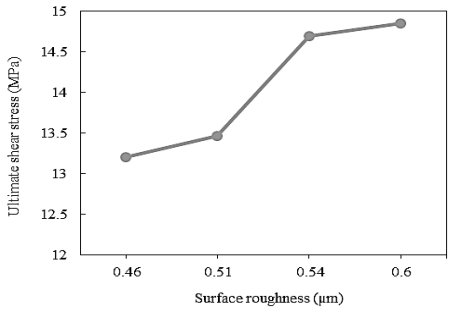

Fig.2. Ultimate shear strength-surface roughness of sandblasted samples and Araldite 2015 adhesive

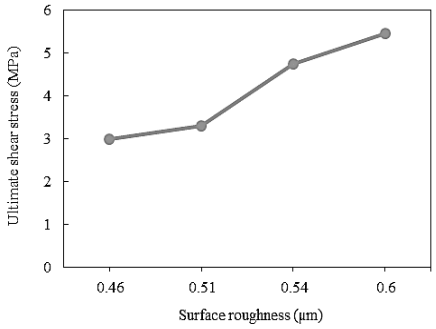

Fig.3. Ultimate shear strength-surface roughness of sandblasted samples and epoxy adhesive

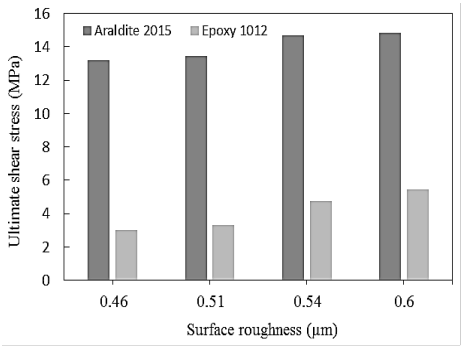

Fig.4. Comparing the values of ultimate shear strength-surface roughness of sandblasting samples

Figs. 5 and 6 represent the ultimate shear strength of the joint surface versus the roughness of shot blasted samples. Two different adhesive types, Araldite 2015 adhesive and epoxy adhesive were used. Comparison between the ultimate shear strength-surface roughnesses of shot blasted samples was shown in Fig.7.

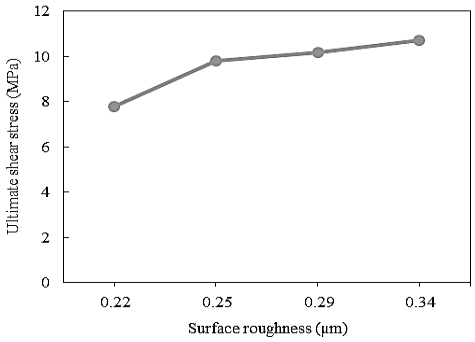

Fig.5. Ultimate shear stress-surface roughness of shot blasted samples and Araldite 2015 adhesive

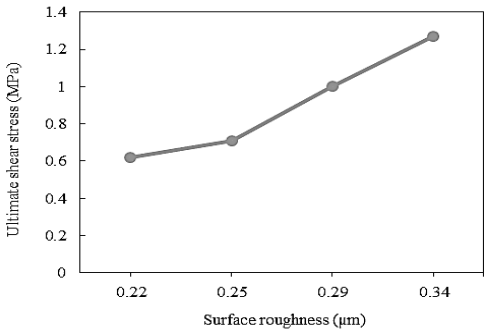

Fig.6. Ultimate shear stress-surface roughness of shot blasted samples and epoxy adhesive

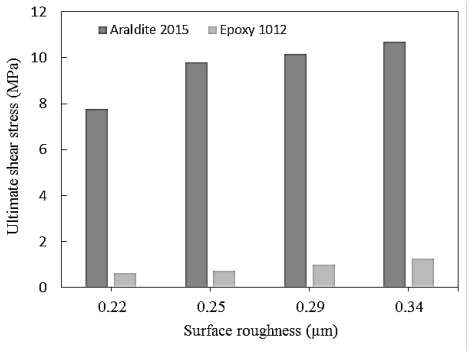

Fig.7. Comparing the values of ultimate shear stress-surface roughness of shot blasting samples

4- Conclusions

The results of this research were summarized as follows:

- By increasing the sandblasting pressure and shot blasting time, the surface roughness increases almost regularly. The average surface roughness of shot blasted specimens is about half times the sandblasted ones.
- There is a linearly increasing relationship between the surface roughness and ultimate shear strength in sandblasting and shot blasting. Shot blasted specimens always have a lower strength in comparison to the sandblasted specimens.
- The optimum surface roughness in shot blasting and sandblasting specimens is the same for both the high and low viscosity adhesives. It shows the independence of these methods from the type of adhesive.
- The maximum ultimate shear strength of the adhesive joints was observed in the specimens prepared by

sandblasting under 6 bar pressure with 0.6 μm surface roughness.

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