نشریه مهندسی مکانیک امیرکبیر

Amirkabir Journal of Mechanical Engineering

Amirkabir J. Mech. Eng., 50(3) (2018) 201-204
DOI: 10.22060/mej.2017.12965.5484

Study on the Effects of Sanding on the Strength of the Adhesive Joints

A. Safari, M. Farahani*

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

ABSTRACT: In this paper, the surface roughness obtained from sanding was studied and its effect on the shear strength of single-lap adhesive joint was examined. 2024-T3 aluminum sheets were cut into standard pieces and then sanded with seven sandpapers. Pairs of prepared surfaces were attached using two-part Araldite 2015 adhesive with a high viscosity and HPL1012/HPH112 epoxy with a low viscosity. Results show that the ultimate shear strength initially increases and then decreases as surface roughness is increased. The optimum surface roughness is not the same for both high and low viscosity adhesives, which shows the dependency of this method on the type of adhesive. The maximum ultimate shear strength for Araldite 2015 adhesive joints was obtained for sanding with sandpaper number 400 with 0.3 μm surface roughness and was equal to 12.98 MPa. The maximum ultimate shear strength of Epoxy HPL1012/HPH112 adhesive joints was obtained for sanding with sandpaper number 120 with 0.35 μm surface roughness and was equal to 5.02 MPa.

Review History:
Received: 3 June 2017
Revised: 5 July 2017
Accepted: 16 July 2017
Available Online: 18 July 2017

Keywords:
Surface roughness
Sanding
Surface preparation
Single lap joints
Adhesives

1- Introduction

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

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

Adhesive joints face some limitations, one being a dependency of strength on the quality of joint surfaces. The adhesive joint strength depends on the surface preparation, environmental conditions, loading and joint design [4]. Mechanical surface preparations have been proposed to strengthen metal joints. Using appropriate preparation processes is effective for improving the strength of adhesive joints [5].

Sinan et al. examined the effect of adhesive thickness and overlap length on the adhesive joint strength by sanding. They examined samples of three different adhesive thicknesses and three overlap lengths joined with three common epoxy-based adhesives. The strength of each joint was determined by axial tension. The results showed that the maximum joint shear strength was provided by the lower overlap length and adhesive thickness. Moreover, the shear strength was reduced as the overlap length increased [6].

In this research, sanding was used as a surface preparation method and the effect of surface roughness on the bonded joint strength was studied. Shear-tension tests and roughness measurement were performed to examine the effect of sanding process on the surface roughness and strength of single-lap adhesive joints.

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

2- Methodology

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

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

Sandpapers, including seven different grit sizes: 40, 80, 100, 120, 220, 400 and 1000 were used. This range seems to be inclusive for examining sandpapers from the roughest to the smoothest grade. Sanding process was performed in one direction prependicator to the loading direction in 10 minutes.

The roughnesses of surfaces were measured by Hommelwerke TK300 machine. 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 comparison between surface roughness values of different grain numbers of sandpaper is shown in Fig.2. Using Araldite 2015 and HPL1012/HPH112 epoxy adhesives, the specimens were bonded. The tensile test was performed at 0.5 mm/s using Shijin WDW-300E testing machine.

3- Results and Discussion

The obtained results are summarized in Figs. 3 to 5. Ultimate shear strength versus the surface roughness of sanded samples for both epoxy and Araldite 2015 adhesives are shown in

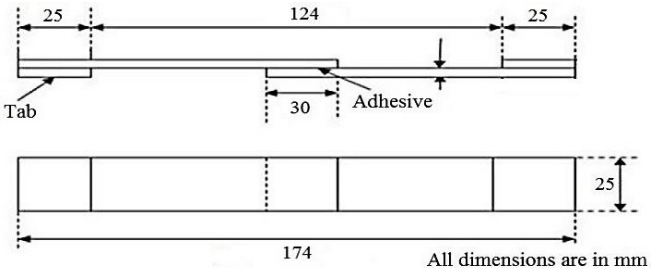

Fig. 1. Dimensions of tensile test sample according to ASTM D 5868

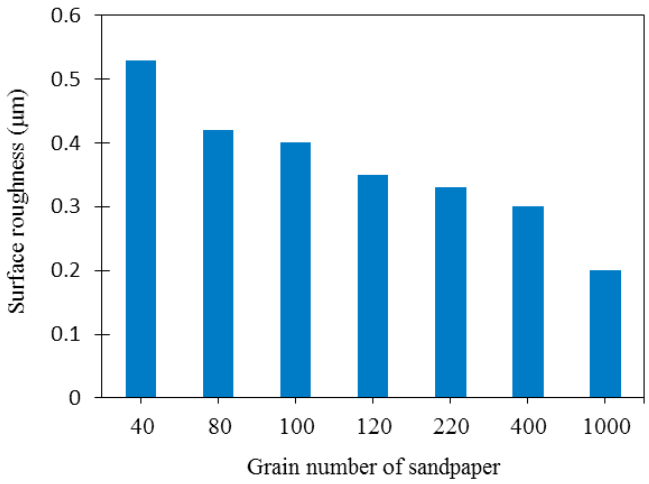

Fig. 2. Comparison between surface roughness values of different grain numbers of sandpaper

separate images. Comparing the ultimate shear strength versus the surface roughness of the sanded samples is also shown in Fig.5.

In very smooth surfaces, contact area and mechanical continuity are lost between the surfaces and consequently the joint strength is reduced. As the roughness of the jointed parts increases, the contact area between the adhesive and jointed parts is also increased which leads to more adhesive diffusion. When the surface roughness is excessively increased, strength is reduced again. For both very smooth and very rough surfaces, a lower shear strength was observed.

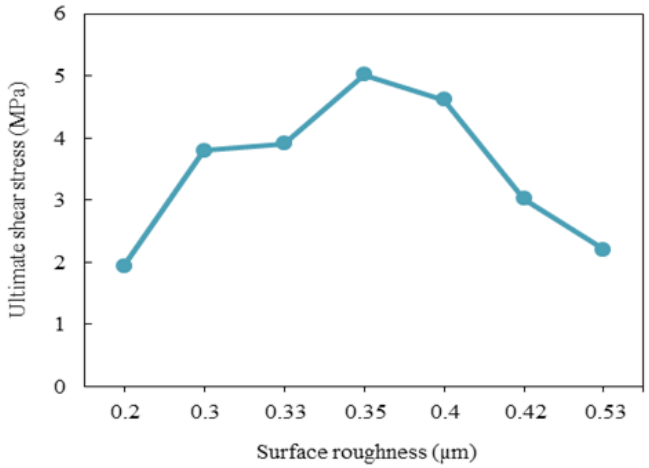

Fig. 3. Ultimate shear strength -surface roughness of sanded samples and epoxy adhesive

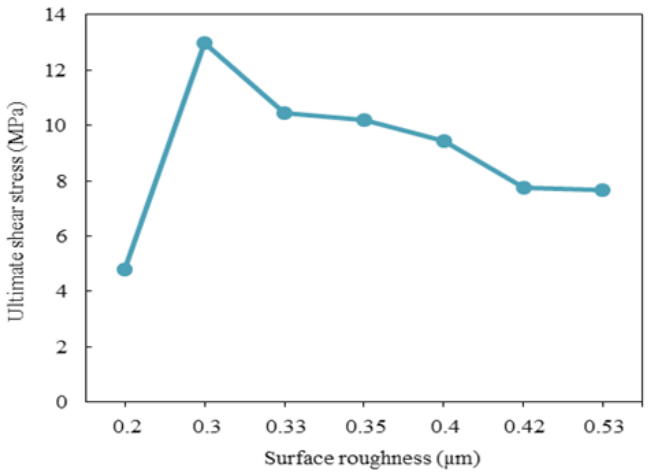

Fig. 4. Ultimate shear strength -surface roughness of sanded samples and Araldite 2015 adhesive

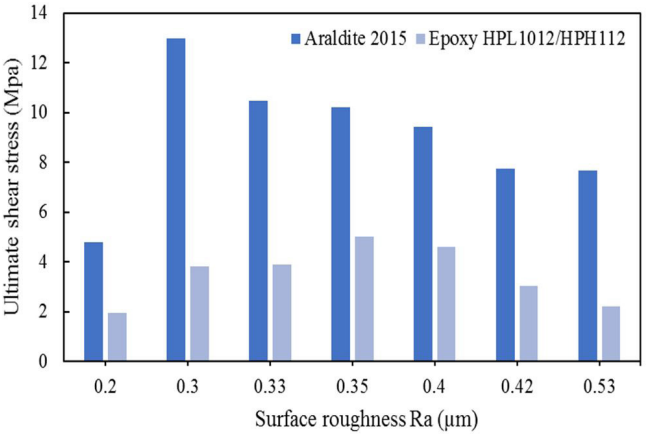

Fig. 5. Comparing the values of ultimate shear strength-surface roughness of sanded samples

4- Conclusions

The results of this research are summarized as follows:

- Surface roughness increases non-linearly as sandpaper grade is reduced. The variations are more intense for sandpapers of low grade.
- In the specimens with the sanded joint surface, the ultimate shear strength initially increases and then continuously decreases as surface roughness is increased.
- Optimum surface roughness in sanding is not the same for brittle and ductile adhesives. The optimum roughness for Araldite 2015 adhesive was 0.30 µm while for HPL1012/HPH112 epoxy adhesive was 0.35 µm.
- The difference in adhesive wettability can be considered as the reason for the difference in optimum roughness for the tough two-part high viscosity Araldite 2015 and brittle low viscosity HPL1012/HPH112 epoxy adhesives.

References

[1] R.M. Jones, *Mechanics of Composite Materials*, Scripta Book Company, Washington DC, 1975.

[2] P.M. Lonardo, A.A.G. Bruzzone, Influence of Surface Roughness Parameters on the Mechanical Strength in Metal Gluing, *CIRP Annals*, 38(1) (1989) 571-574.

[3] M. Banea, L.F. da Silva, Adhesively bonded joints in

composite materials: an overview, Proceedings of the Institution of Mechanical Engineers, *Part L: Journal of Materials: Design and Applications*, 223(1) (2009) 1-18.

[4] S.-Y. Fu, X.-Q. Feng, B. Lauke, Y.-W. Mai, Effects of particle size, particle/matrix interface adhesion and particle loading on mechanical properties of particulate–polymer composites, Composites Part B: Engineering, 39(6) (2008) 933-961.

[5] A. Rudawska, Selected aspects of the effect of mechanical treatment on surface roughness and adhesive joint strength of steel sheets, *International Journal of Adhesion and Adhesives*, 50 (2014) 235-243.

[6] S. AYDIN, M.Y. SOLMAZ, A. TURGUT, The effects of adhesive thickness, surface roughness and overlap distance on joint strength in prismatic plug-in joints attached with adhesive, *International Journal of Physical Sciences*, 7(17) (2012) 2580-2586.

Please cite this article using:

A. Safari, M. Farahani, Study on the Effects of Sanding on the Strength of the Adhesive Joints, *Amirkabir J. Mech. Eng.*, 50(3) (2018) 619-626.

DOI: 10.22060/mej.2017.12965.5484