INFLUENCE OF PERFORATIONS ON FLEXURAL STRENGTH OF ALUMINIUM 8090 ALLOY SHEETS

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ABSTRACT

Reliable knowledge about flexural strength of sheet metals is very important for sheet metal bending process. Young's modulus and cross sectional area determine the flexural strength of sheet metals. For perforated sheet metals, the presence of holes reduces the cross sectional area and hence the flexural strength is affected. In this paper, an attempt is made to study the influence of presence of holes on flexural strength of Aluminium 8090 alloy sheets. Experiments are conducted to study the influence of hole size, percentage of open area and hole arrangement pattern.

Keywords: aluminium 8090 alloy, flexural strength, hole size, open area.

INTRODUCTION

Perforated sheet metal allows for a variety of standard designs, making it easy to use for a number of purposes. Perforated material has many potential uses to industry as well as to architects and designers because of its practical and aesthetic features. Perforated material is used for outdoor furniture, acoustic panel, exterior and interior cladding, ventilation, air conditioning systems, suspended ceilings and interior heating, balustrades. The use of perforated sheet metals, both in industrial and domestic, lead the researchers to study its flexural strength. Perforated sheets made from aluminium alloys are multipurpose because of their light weight construction.

Literature review

The literature review is dealt in two aspects. First aspect deals the literature on flexural strength and second deals on perforated sheet metals. Gnanamoorthy *et al*. investigated the influences of microstructure, alloying conditions and processing method on flexural strength of gamma base titanium aluminides. The authors concluded that the flexural strength strongly depends on the said parameters. Dong and Sause performed a parametric study to find the influence of geometric imperfections, residual stresses and cross section dimensions on flexural strength of tubular flange girders. Alander *et al*., studied flexural strength and flexural modulus of fibre reinforced composite materials by varying cross-sectional areas, diameters and span lengths. Capek and Vojtech studied the influence of porosity on porous magnesium based materials. Ren *et al*. investigated flexural strength of magnetic alloys as a function of temperature, loading direction and magnetization. Venkatachalam *et al*. (2011) probed stress strain relations in the plastic zone and also investigated the effective yield stress and effective stiffness of perforated sheet metals with square and hexagonal holes using Finite Element Method. Lee and Chen (2000) investigated the plastic behavior of perforated sheet with round holes in a triangular pattern with low ligament ratio and proposed a yield criterion for the perforated sheets in terms of apparent stresses by employing the equivalent-continuum approach. Venkatachalam *et al*. (2012-1) predicted limiting strain for square perforated aluminium sheets in the negative minor strain using finite element method. Venkatachalam *et al*. (2012-2) studied the influence of hole shape and hole arrangement pattern on limiting strain in the negative minor strain region using finite element method. An attempt is made here to evaluate flexural strength of perforated aluminium 8090 alloy sheets and also to study the influence of open area, hole size and hole arrangement pattern on flexural strength.

METHODOLOGY

Perforated sheets are designed based on varying open area, hole size and hole arrangement pattern. Aluminium 8090 alloy is considered for the purpose. Samples of 300 mm length are considered whose cross section is 28 mm x 1.5 mm. The above mentioned sample size is considered in all three cases i.e., open area, hole size and hole arrangement pattern. The percentage of open areas considered here are 0%, 0.75%, 1.5%, and 2.25%. The hole sizes considered are 4 mm, 6 mm, 8 mm and 10 mm. Triangular arrangement of holes and square arrangement of holes are considered. Some of the sample sheets before drawing process are given in Figures 1-5.

Figure-1. Sheet with 0.75% open area.

Figure-2. Sheet with 1.5% open area.

Figure-3. Sheet with 2.25% open area.

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Figure-4. Sheet with holes arranged in square pattern.

Figure-5. Sheet with holes arranged in triangular pattern.

RESULTS AND DISCUSSIONS

The flexural strength for different open areas is shown in Figure-6. From the graph, it is seen that flexural strength of specimen without holes (i.e., continuum sheet) is higher than that of specimens with holes. This shows that presence of holes decreases the flexural strength of sheet. The presence of holes in the specimen increases the deflection and it has direct impact on the values of flexural strength. But the difference in the flexural strength among the specimens with holes is modest. Figure-7 provides the control of hole size on flexural strength. Hole sizes of 4 mm, 6mm, 8mm and 10mm are considered for the analysis. Flexural strength decreases when the hole size increases. Perforated sheets of larger holes will deflect faster than that of smaller holes. Figure-8 presents the influence of hole arrangement pattern in sheets on flexural strength. Circular holes arranged in triangular pattern and circular holes arranged in square patterns are compared in Figure-8. In square pattern, area of cross section is less if the section is considered along the centre of the holes and hence moment of inertia is less along the centers of the holes. The low moment of inertia has its influence in the value of flexural strength and hence the flexural strength is high for triangular pattern than square pattern. Triangular pattern of hole arrangement is safer than square pattern of hole arrangement in terms of flexural strength.

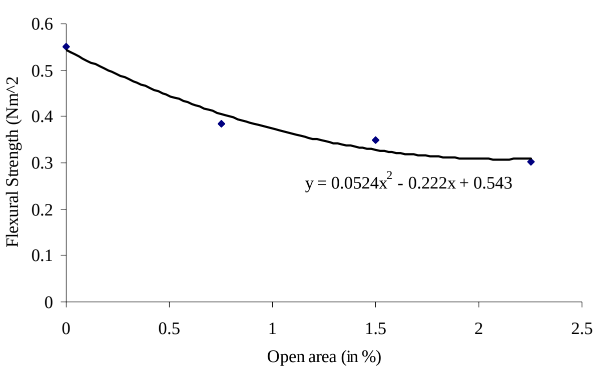

Figure-6. Flexural strength Vs open area.

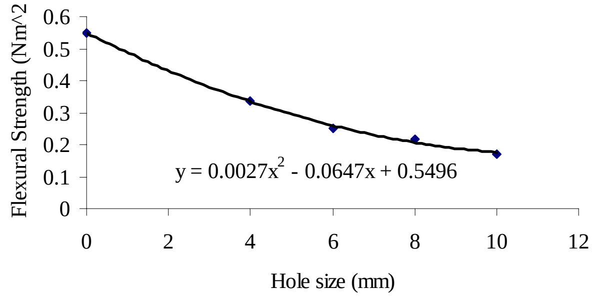

Figure-7. Flexural strength Vs hole size.

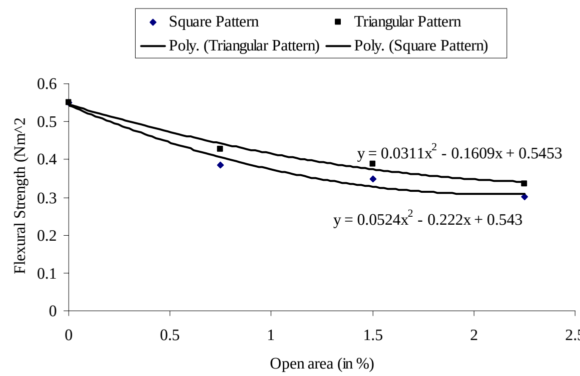

Figure-8. Flexural strength Vs open area (for square and triangular pattern).

CONCLUSIONS

Flexural strength of sheet decreases when percentage of open area of sheet metal increases. Hole size of the perforated sheet metals too influences on flexural strength of perforated sheet metals and hence the increased hole size decreases the flexural strength. Flexural strength is high when the holes are arranged in triangular pattern and it is less in the case of square pattern (i.e., holes arranged in square pattern).

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