FATIGUE CURVES FOR ALUMINIUM BRAZED AREAS

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Abstract *An important factor for the quality of joints is the brazed area. The fatigue check occupies a major position among many test procedures and methods, especially by the joining technologies. The results of processing the fatigue data experiments for aluminium brazed probes are used to find the regression function and the response surface methodology.*

K**eywords**: brazed joints, regression, durability

1. INTRODUCTION

The fatigue process of mechanical components under service loading is stochastic in nature. The prediction of time-dependent fatigue reliability is critical for the design and maintenance planning of many structural components [6].

The paper focuses on the development of the new technologies in the field of materials joining by welding and brazing and the processing of the obtained data from the fatigue tests of the probes through these technologies [1;8;10]. Here the experiments are applied to aluminium small pieces :1.47 mm thick, from **AL 103** cf. British Standard BS EN 1044:1999 (BSI 2) [2;5] (fig.1).

Fig.1.Samples for fatigue test [6].

The brazing operations were carried out in an electric oven radiant resistance at the temperature of 570^{0}C and the samples were cooled in the atmosphere [6]. To assure a right orientation of researches it was tried from the start, from the first set of experimental data, to establish the dependencies and interactions between the studied issues, respectively force or stress to which the samples have been subject, the brazed area, as dependent factor and the resultant, number of cycles until the fracture.

2. FATIGUE CORRELATION

The inherent nature of fatigue tests gives rise to a great deal of scatter in the data [4]. For example, if several specimens that have been carefully machined and polished, are tested at the same stress level, it certainly not unusual to have a variation of 10 to 20 percent in their fatigue life measured in terms of the number of loading cycles at which the specimen ruptures [3]. It therefore requires many tests to adequately quantify an S-N curve for a given material [4]. In this case it was evaluated the correlation between the stress (Y axis) and the number of cycles (X axis), corresponding to the classical fatigue tests, calculating the regression function with software CurveExpert 3.1. The small number of data offers a huge fitting flexibility of the experimental data. The yield is a lot of forms of the regression functions and a few among these were selected below:

Vapor pressure model :

$y = e^{a+\frac{b}{x}+c\ln x}$, cu a=442, b=-104382, c=-50. (1)

Geometric fit:

$y = ax^{bx}$, cu $a=7.96*10^{8}$, $b=4.3*10^{-4}$ (2)

Modified power:

$y=ab^{x}$, cu $a=2.5*10^{9}$, b=0.996 (3)

Exponential fit:

$y=ae^{bx}$, cu $a=2.51*10^{9}$, $b=-3.84*10^{-3}$ (4)

As example it was chosen the last function, Exponential fit, with a standard error of the estimate S=1061.6 and modified correlation coefficient r=0.99998, plotted in fig.2, which is closer to the classical fatigue curves.

3.DURABILITY EVALUATION

Despite extensive progress made in the past decades, life prediction and reliability evaluation is still a challenging problem [6]. In the next step it was searched the dependency of the number of cycles, considered as an assessment of the fatigue durability and even of the reliability, following this criterion. As influence factors it was considered the stress (X_1), the surface of the brazed area (X_2), their product (X_1X_2) - the loading force, and the dependent variable (Y), the number of cycles (tab. 2).

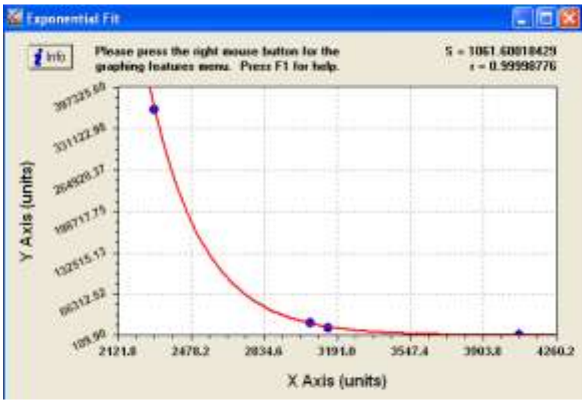

Table 1. Experimental data

	m_{ed}	Area	Force	Cycles number
1	2300	495	1138500	361305
2	4082	459	1873638	1099
3	3064	477	1461528	19926
4	3149	477	1502073	12744

Fig.2.Regression curve

A new regression calculus was applied, with a bivariate quadratic function, this time using Excel (tab.3) with Analysis Tool Pack (tab.2, 3, 4).

Table 2. *Experimental data for bivariate function*

B	C	D	E
x1	x2	X1X2	y
2300	495	1138500	361305
4082	459	1873638	1099
3064	477	1461528	19926
3149	477	1502073	12744

Table 3.*Regression summary*

	A	B
1	SUMMARY OUTPUT	
2		
3	*Regression Statistics*	
4	Multiple R	1
5	R Square	1
6	Adjusted R Square	65535
7	Standard Error	0
8	Observations	4

After the regression calculi the following values were obtained:

Table 4. *Regression results*

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	9.21E+10	3.07E+10	#NUM!	#NUM!
Residual	0	0	65535		
Total	3	9.21E+10			

	Coefficients	*Standard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	-1.9E+07	0	65535	#NUM!	-18823402.59	-1.9E+07	-1.9E+07	-1.9E+07
x1	5031.307	0	65535	#NUM!	5031.307176	5031.307	5031.307	5031.307
x2	40046.58	0	65535	#NUM!	40046.57981	40046.58	40046.58	40046.58
X1X2	-10.725	0	65535	#NUM!	-10.7249503	-10.725	-10.725	-10.725

$$y = -19*10^6 + 5031*x_1 + 40046.58*x_2 - 10.725*x_1*x_2 \quad (5)$$

and the response surface was plotted with LabFit (fig.3)

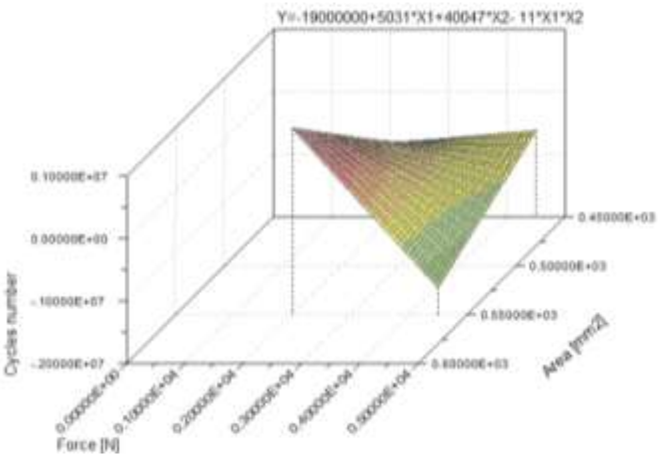

Fig.3 Response surface plot

4.CONCLUSIONS

The paper offers a synthesis between the engineering experimental activity and the modern statistical applications, computer assisted. The applied statistical methods carried out some correlations, interdependences regression functions to evaluate the initial experimental results for aluminium brazing.

The continuation of the experiments will offer the possibility to verify the inference of the mathematical expressions, to assure the consistency of the subsequently statistical evaluations.

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