Review of: "An Approach to Robust Fatigue Life Prediction to Be Used in Early Design Stages"

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The article discusses the application of methods from the design of experiment theory to the problem of determining the geometric parameters of a load-carrying structure. At the same time, the authors emphasize the need to ensure the robustness of the design method.

The proposed version of the article seems rather crude and requires improvement for the following main reasons:

1). The introductory part of the article begins with a statement of the problem of linear experiment designing. The need to solve this problem in order to achieve the stated goal has not been explained. It would be advisable to begin by stating and discussing the features and methods of solving structural design problems, and at the same time showing the role and necessity of using experimental design. Then it will become clear why it was necessary to lay out the basics, which can be found in every textbook on experiment designing.

2). The considered example (the determination of the internal diameter and radius of the fillet of the wheel axle) does not justify the need to use the approach proposed by the authors and develop robust design methods, since the resulting solution (the diameter should be minimal and the radius should be maximum) is trivial and can be proposed without any calculations. It is obvious that, in addition to restrictions, a criterion for the quality of the solution (for example, the mass of the chassis) must be introduced into the problem statement. Then the solution corresponding to the boundary of the feasible region will no longer be optimal. The authors can say that they used the service life as a criterion. In real designing, it will be not correct, especially in aircraft engineering. The structure will be infinitely reliable but not applicable, because of the excess weight. Therefore, the service life is usually considered as a limitation but not a criterion of quality.

3). The authors repeatedly insist on the need to use a robust design method. However, nowhere is it explicitly stated what they mean:

- what is “robustness of the life-time determination method”?
- to changes in which factors (for example, properties of materials, geometry of parts, variation in operating conditions, etc.) should this method be robust?
- how to quantitatively characterize robustness (without this, it is impossible to compare different methods with each other and choose the best one)?
- what method do they consider as the initial, basic, that is, not robust (without this, it is impossible to determine whether the proposed approach gives positive results)?

In addition to these general comments, as we read the article, the following questions and comments arose, consideration of which may help improve this publication:

1). Figure 1 shows that creep analysis is performed before stress determination. How can we analyze creep if we do not know what stresses are acting in the part?
2). In section 2.2, the authors, without the necessary explanations, consider only information about two-level factorial experiments, which is suitable only for linear systems. At the same time, it is known that the mechanical (including strength) properties of materials are often nonlinear.
3). At the end of section 2.2, the authors write that often the result of computational transformations of random variables turns out to be normally distributed due to the action of the central limit theorem of probability theory. This statement is true, but is not relevant to the considered example of residual stresses. The conditions of this problem (only two random variables are summed) are very far from the conditions of the indicated theorem. Therefore, if the load and/or strength are not distributed according to a normal law, then the distribution of residual stress will not be normal.
4). In formulas (2) and (3), the parameter σUTS is not deciphered.
5). When describing the finite element model of the design object, information about the used conditions for fastening the part should be provided, since they have a significant impact on the stress distribution in the part, especially in the studied area of stress concentration.
6). It is not clear what “1.1” means in the line following the inscription under Table. 4.
7). It is not clear why in Sect. 3.5, when forming Fig. 15 and Table. 5, options were considered that went beyond the specified limitations (for example, D=13 mm and R=2.6 mm).
8). Without explanation, they assume that the dispersion of factors is constant and does not depend on their values, which in reality is not observed. Only in section 4.1 does information appear that the specified limits of parameter variation correspond to the 95% confidence region. On what basis was this done? These limits may generally not be related to scatter and random factors. For example, it is obvious that the spread of loads corresponding to a rough landing is much greater than for a soft landing.
9). As follows from Table. 2, the standard deviation of parameter A1 is almost 3 times less than the standard deviation of parameter A2. However, in Fig. 16 and in Table. 6, we observe the opposite picture: for fixed values of A1, the spread associated with changes in A2 is significantly greater than the spread associated with changes in A1 for fixed values of A2.
10). The considered example does not provide recommendations on how to obtain a solution to a problem if it is not located on the boundary of a given parameter change area, but inside the change area.
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11). The last conclusion (at the end of the article) is questionable, since the safety margin is of a probabilistic nature and can be considered as a quantile of the distribution of the ratio of the ultimate stress to the effective stress.