STRESS CONCENTRATION IN INCLINED BAR AND BEAM SHOULDERS

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The paper deals with stress concentration in inclined bars and beams, where the shoulder radius is often not prescribed in the detail drawings. The commonly accepted notch definition as a stepwise change of the beam cross section, as well as a lack of nomograms or other data on stress concentration in inclined shoulders in the available literature ([1], [2], [3]) support the assumption of negligible stress concentration in inclined shoulders. Several failures of shaft-like components with inclined shoulders made us to investigate the stress concentration in these shoulders. Computational modelling confirmed a rather high stress concentration even in shoulders with a very low inclination β angle. Even in the case of $\beta = 30^\circ$, the stress concentration factor is only slightly lower than in a comparable perpendicular ($\beta = 90^\circ$) shoulder. Therefore nomograms for evaluation of stress concentration factors in inclined bar and beam shoulders under basic loading types were created and published in the paper.

Key words: *inclined shaft shoulder, stress concentration factor, beam, bar under tension and torsion*

1. Introduction

The problem solved in this paper was set off by failures of shanks produced according to the drawing in Fig. 1. If you cannot find any mistake in this drawing, you can try to answer a question concerning drawings in figures 2 and 3. The question is very easy at first appearance: which of these two shaft shoulders causes higher stress concentrations when loaded e.g. in tension. If you are not in doubt that the stress concentration in the bar in Fig. 2 (inclined with angle $\beta = 30^\circ$) is indeterminate because of the non-prescribed radius and that it can be even much higher than in the perpendicular ($\beta = 90^\circ$) bar shoulder in Fig. 3, it is not necessary for you to continue reading this paper. Only if you needed to quantify the stress concentration in the inclined shoulder, you could be surprised that there are neither data nor nomograms available in the literature (e.g. [1], [2], [3]) dealing with evaluation of stress concentration factors for this type of bar shoulder.

However, if you accept the drawings in figures 1 or 2 like many designers omitting to prescribe the radius in the case of a shoulder with such a low inclination angle as $\beta = 30^\circ$, because it is supposed not to cause any substantial stress concentration, then you are strongly recommended to scan the nomograms presented below. You may be surprised that, in the case of radius as large as $R = 0.4\,\mathrm{mm}$, the stress concentration factor in the shoulder with inclination angle $\beta = 30^\circ$ counts $\alpha_\beta = 2.35$ (for $D = 20$, $d = 10$) and is significantly higher than that in the perpendicular shoulder in Fig. 3 ($\alpha = 2.0$ for the same dimensions) where the radius is defined. If the radius of an inclined shoulder is not prescribed in a drawing,

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