DETERMINATION OF DIAGRAMS FOR DETERMINING OF SHAPE FACTOR α

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Abstract
Creating charts to determine the shape factor α. Experimental determination curves diagrams comparing the previously used charts and monograms. The beginning of the development of appropriate calculation methods for determining courses of stress concentration factor for individual notches, with the previously used charts.

Key words: *Diagram, Coefficient, Tension*

INTRODUCTION

Diagrams and monograms (**Fig. 1**) serve to determine a shape factor that causes stress concentration and thus negatively affects the life of machine parts. These diagrams have been known since the early 20th century. All stress concentration coefficients listed in diagrams, nomograms or calculated by formulas have been determined in the last century. At this time, we can use modern computational methods, such as FEM. However, the designer have not always opportunity, apply methods like FEM analysis. But no one knows how they were designed or acquired in the past.

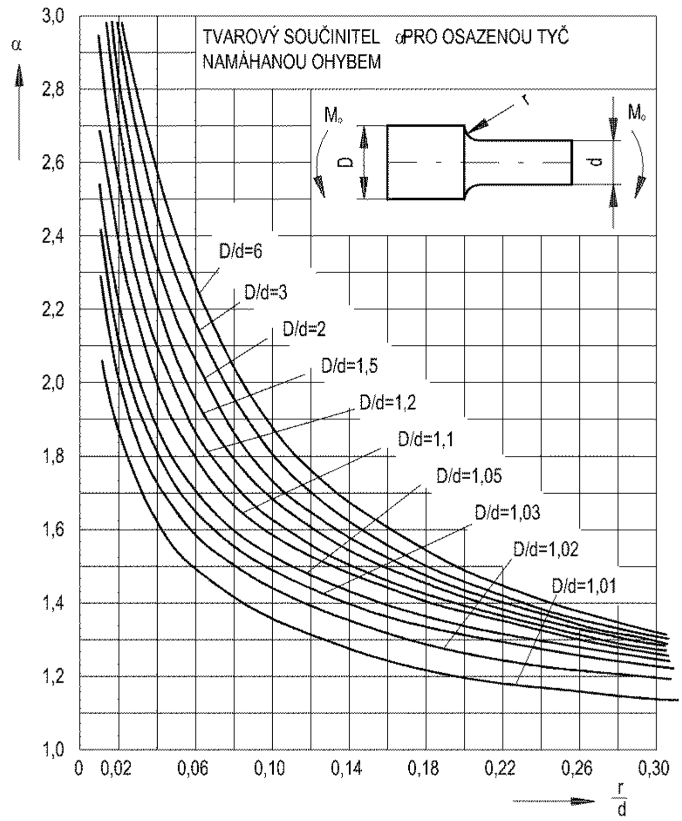

Fig. 1. Diagram of the stress concentration coefficient for the bending stress

Dependence of the determination of the shape factor depends on the size of the shaft and on the transition between the individual diameters. The smaller radius, has the higher pike tension, and vice versa. How, did the slope of each curve arise when there were no computational programs?

MATERIALS AND METHODS

As already mentioned, the value of the shape factor depends on the dimensions of the shaft and the transition between the diameters. According to known monograms, the slope of the curve is different for each parameter.

But, how can you get it, for different dimension of shaft? For determination of curves we use calculation, where we use MKP software (Ansys). Where the dimensional values of the shaft (radius r), we assigned parametrically. Four samples were selected, with other transition values (value radius r), but with the same D/d value and value r/d. The radius was variable – **Fig. 2**.

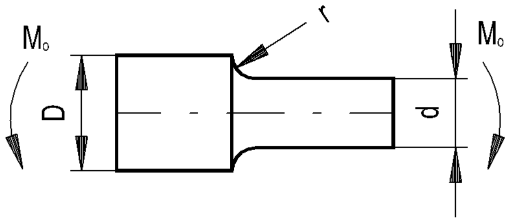

Fig. 2. Scheme of the test sample

Example of parameters for each sample you can see in the Tab. 1.

Tab.1 Example of parameters for calculation

	d	D	D/d	R	R/d
Sample 1	29	32	1,10	0,6	0,02
				1,8	0,06
				3	0,10
				4	0,14
				5,2	0,18
				6,4	0,22
				7,5	0,26
				8,7	0,30
Sample 2	32,7	36	1,10	0,6	0,02
				1,8	0,06
				3,2	0,10
				4,5	0,14
				6	0,18
				7,3	0,22
				8,5	0,26
				9,8	0,30

Use an empirical relationship (1) for calculate the bending concentration tension in the critical location on the shaft

$$\sigma_O = \frac{M_O}{W_O} \cdot \alpha \qquad (1)$$

For shape concentration factor α we use formula (2):

$$\alpha = \frac{\sigma_O \cdot W_O}{M_O} \qquad (2)$$

Where *Mo* is bending moment (Nm), *Wo* is cross section bending module (mm^2), σ_o is bending tension (MPa) and α is shape concentration factor (-).

We used the FEM software Ansys, we determinated the maximum voltage peak of tension at the transition point - between diameters. After that for each sample we determinate the value of the shape coefficient α was determined for the individual calculations that were entered into the graph and, with the help of the trend line, the curves for each sample were drawn. Samples in the graph, have a label "*S*", for example (S1 = sample 1) - **Fig. 3**

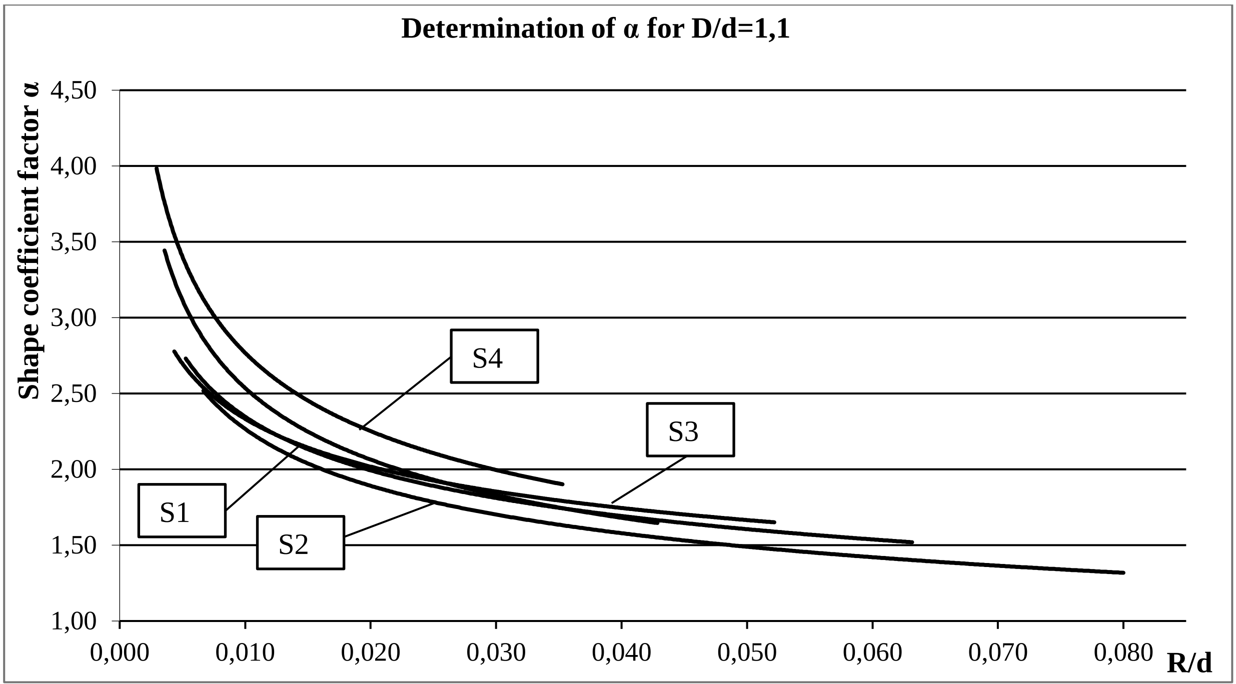

Fig. 3. Determination of shape coefficiente α for D/d=1,1

The graph (**Fig. 3**) shows, that each test sample has a different waveform. For each sample, we applied the same parameter of bending moment. And for each calculation we got a different maximum value of voltage peak in the transition between the diameters. Sample with small radius *r* is more sensitive (bigger tension) than a sample with bigger diameters. When we conected the values of the outermost curves, we find that it is a bounded area. This area depends on the number on the samples. For this reason, we toke the arithmetical value from this area, and we got a curve for parameter D/d=1,1 – **Fig. 4**.

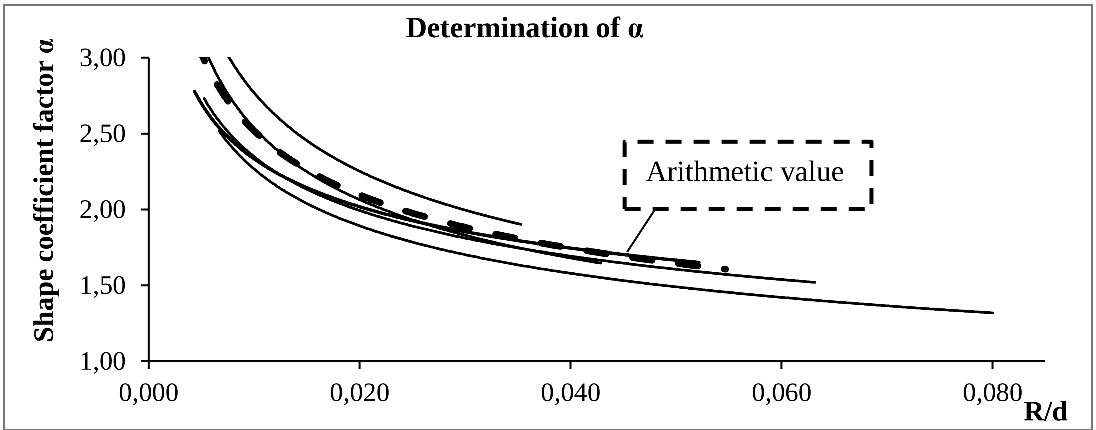

Fig. 4. Determination of shape coefficiente α for D/d=1,1

RESULTS AND DISCUSSION

We can see the common historical monogram (**Fig.5**).

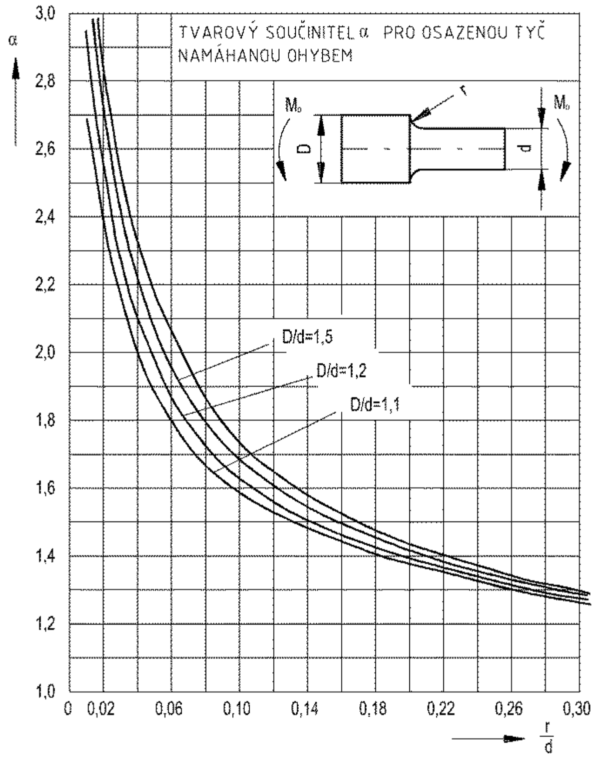

Fig. 5. Diagram of the stress concentration coefficient for the bending stress – chose curves

And compare with created monogram, we can see same similar slope of curves – **Fig. 6**.

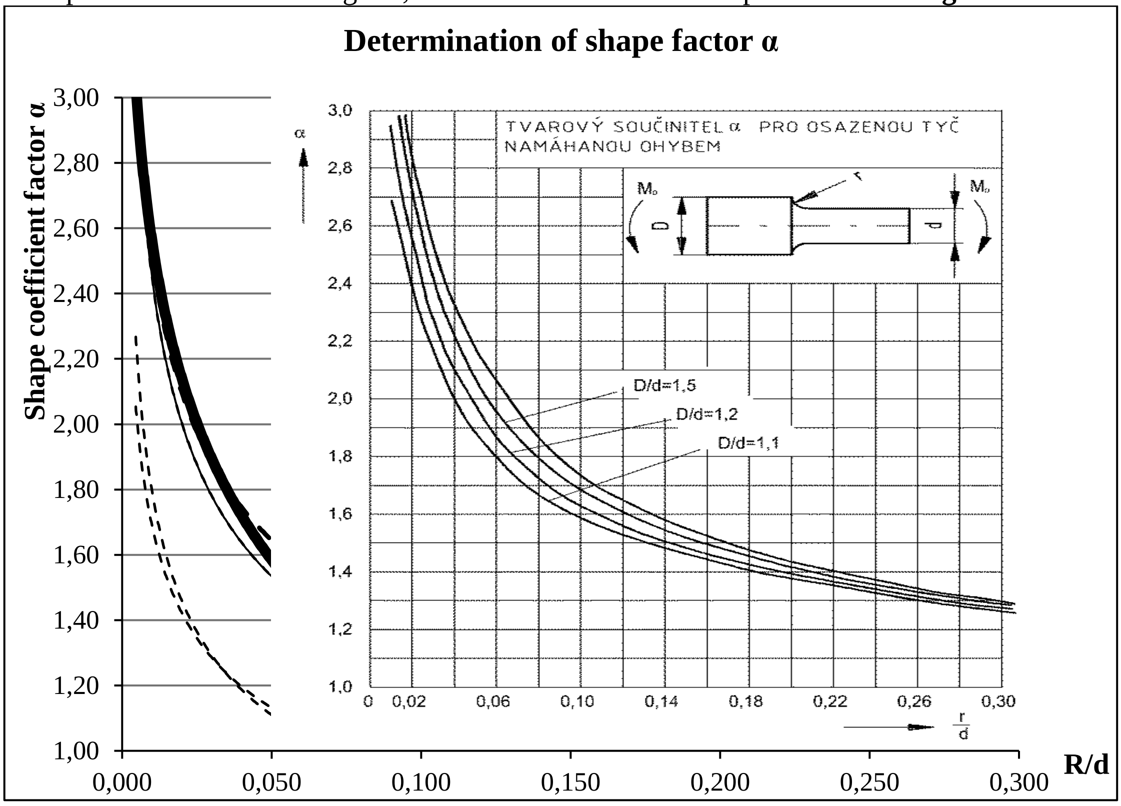

Fig. 6. Comparison of diagram D/d=1,1

As already mentioned, each parameter D/d has a different slope of the curve. For better understanding, now we compare the historical monogram, where are curves for values of the parameter D/d = 1.1, 1.2 with identical r / d. For the method of calculation, the values of samples were similar to historical. Parameter D/d = 1.1, 1.2 with identical r / d parameters. For each value of D/d we chose four samples, like in previous chapter. Once the individual variables had been determined. We made calculation with MKP analyses, and we got the maximum tension in the transition area. As in the calculation method, the values of the shape factor α for the individual calculations were plotted and plotted for each test sample, as the previous example.

We got a graf – **Fig 7** (for samples D/d=1,1) each sample with the same parameter D/d has a different slope of curve. You can see, that is the boundary area, which depends on the on number of samples, for this reason we use the arithmetic value from this area and we get the slope of curve for parameter D/d.

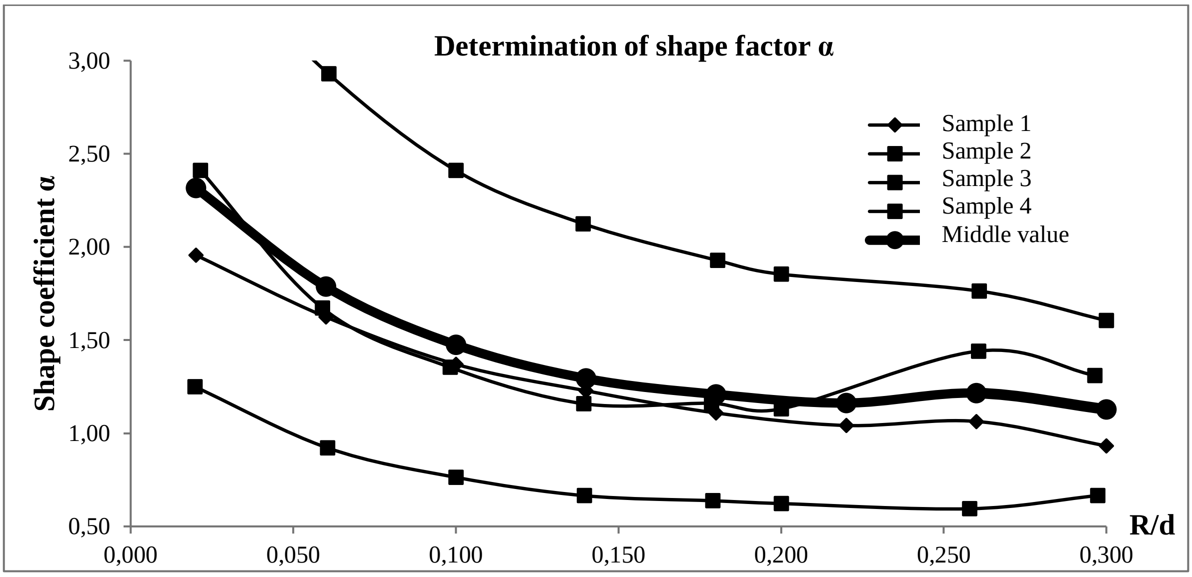

Fig. 7. Determinaton for shape factor α for D/d=1,1

Now, we can compare graphs. We can see some differencis between historical graft and crated graphs.

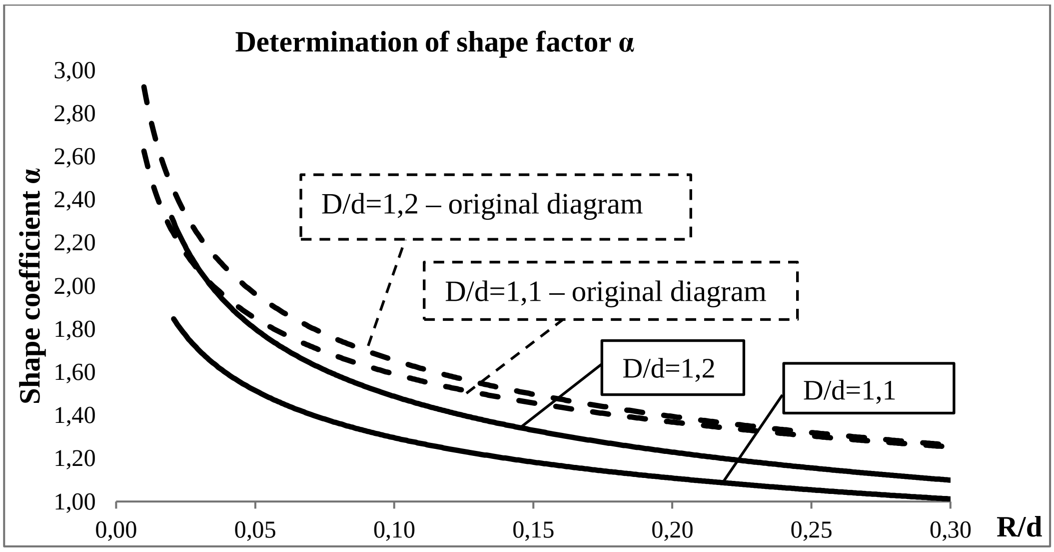

Fig. 8. Compare the diagrams

CONCLUSIONS

Comparison of the experimental determination of curves for a given D/d ratio with previously used diagrams with the same D/d ratio (**Fig. 8**), shows some similarity between these curves that determine the shape coefficient *"α"*. The shapes of curves are similar, but you can see, that are not the same value of shape factor *"α"*. For example, for value R/d on the curve D/d=1,1you can get a different value of *"α"*. As mentioned above, it is not known how the curves originated, without using the necessary method in history. This experiment shows the possible way of determining curves using modern computational methods that were not so common in the past.
These examples show the way, how can you determinate the shape factor *"α"* for danger place on the shaft (transition between diameters).
But on the shaft, exist another places, where is the tension is very dangerous for the lifetime of the shaft, for example, hole through, grooving and groove for pen. According to similar way I will try make shape concentration factor "α"for each concentration place on the shaft, and compare with the historical diagrams.

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SOFTWARE

4. ANSYS Workbench R14

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