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Ioan Golumbu, Cristian Golumbu, Dorian Nedelcu, Peter Lorenz

Calculation of the Pipe Work Concentrator Equipped with Rectangular Openings

The coefficients of stress concentrators, used for most car bodies are known and published in the literature. There are no data on how big is the effort concentrator for tubes fitted with rectangular openings. The aim of the present work is to make available quickly and economically for the design engineer, values used in design and execution without making complicated simulations with numerical methods.

Keywords: *stress concentrators, finite element analyse, pipe*

1. Introduction

The literature provides values for the coefficients of the stress concentrators at stretching/compression, bending and torsion only for the classic bodies. When designing, for example a spindle an engineer can use the values from the literature [1]. For round pipes with rectangular openings no such values exists, and design engineer invests long time in the simulation calculations. The following simulation study proposes the FEM [2] calculation of pipe sections with different diameters and thicknesses as well as different sizes of rectangular openings, to the amount encountered in engineering practice. Pipe shall be subject to bending, twisting and stretching for each application, determining the corresponding coefficient for efforts concentrators. These values should then be considered in strength calculations, for example to determine the equivalent efforts by theories of resistance [3].

For each of the test results will be calculated the α_k coefficient. This coefficient is determined by dividing the maximum effort in the stress concentrators area, in this case right at the opening, to the nominal unit effort without concentrator.

$$\alpha_k = \frac{\sigma_k}{\sigma_N}$$

Given the purpose of this paper, one by one each of the parameters involved in this study will thus vary:

Effort applied for stretching and bending: 50, 60, 70, 80, 90,100 N/mm^2;

And for torsion: 30, 40, 50, 60, 70 N/mm^2;
The outer diameter of pipes: 100, 120, 150, 180, 200 mm;
Fillet radius: 5, 7.5, 10, 15, 20mm.
All tubes have a thickness of 5mm.

The calculations were carried out for all possible combinations, each time by changing only one of the parameters.

For reasons of space will be added only three images , one for each variation, but in the end will be presented in a table all variants of calculation.

2. Tensile test tube

For the first test is used the standard pipe size: D=100mm, σ= 50 N/mm^2, without fillet.

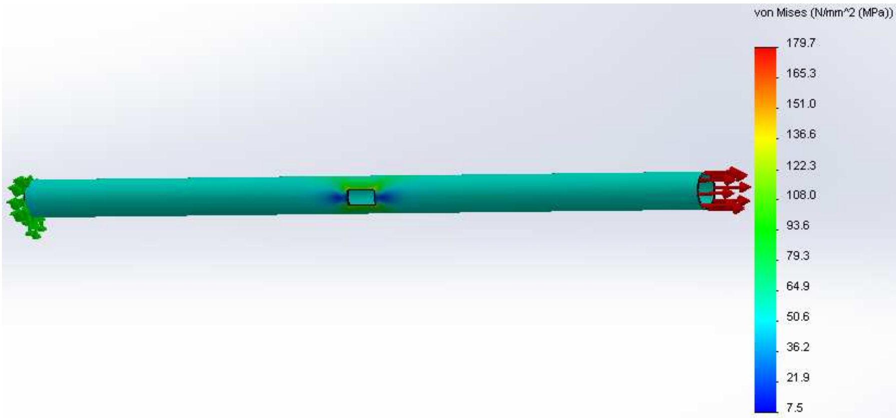

Figure 1. Tensile test 1

Tensile test, the pipe diameter=150mm.

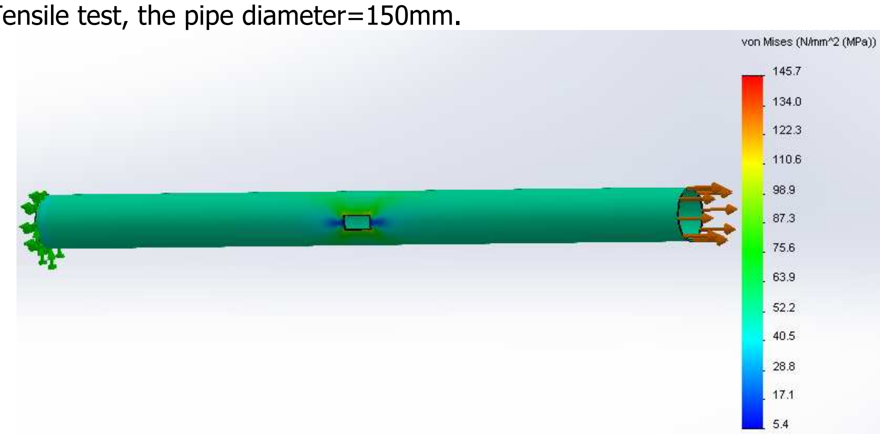

Figure 2. Tensile test 2

Tensile test of the pipe with D=100mm, with r=10mm.

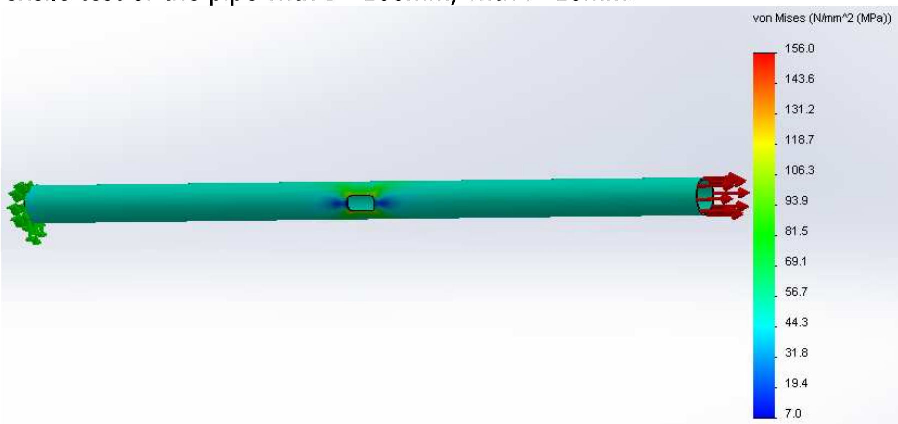

Figure 3. Tensile test 3

Table 1. α_k by σ

σ_N (N/mm^2)	σ_K (N/mm^2)	α_k
50	180	3,6
60	216	3,6
70	252	3,6
80	288	3,6
90	325	3,6
100	361	3,6

Table 2. α_k by diameter

D (mm)	σ_K (N/mm^2)	α_k
100	180	3,6
120	170	3,4
150	150	3
180	144	2,88
200	140	2,8

Tabel 3. α_k by fillet radius

r (mm)	σ_K (N/mm^2)	α_k
5	182	3,64
7.5	164	3,28
10	157	3,14
15	148	2,96
20	149	2,98

3. Conclusions

Stress concentrations are very important and must be considered in design practice. For various combinations of pipe sizes and geometrical dimensions of the opening, the values can be read directly from tables or diagrams of stress concentrators depending on the every applied situation without the need for a costly simulation for every situation.

Concentrator is reduced with increasing in the size of fillet radius at the opening in the pipe, depends only of the discussed geometrical dimensions and is independent of the size of unitary stress effort. Differences occur only between different modes of efforts application.

References

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Addresses:

- M. Sc. Ioan Golumbu, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, i.golumbu@uem.ro
- M. Sc. Cristian Golumbu, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, c.golumbu@uem.ro
- Prof. Dr. Eng. Dorian Nedelcu, "Eftimie Murgu" University of Reşiţa, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, d.nedelcu@uem.ro
- Em. Prof. Dr.Eng.Dr. h.c. Peter Lorenz, „Hochschule für Technik und Wirtschaft des Saarlandes" Saarbrücken, Germany, Goebenstrasse 40, D-66117, Saarbrücken, lorenz@htw-saarland.de