

THE STRESS STATE IN PRESSED PRISMATIC AND CYLINDRICAL SAMPLES

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Abstract: In this study has been analyzed stress state in pressed prismatic and cylindrical samples. After that the most favorable geometric characteristics of samples have been proposed. The diagram for correction of nominal strength on pressure has also been given.

1. INTRODUCTION

For material strength determination are used simple form samples in order that stress state could be as simple as possible. In experimental tension case, it is possible to make a sample where can be completely removed boundary conditions influence, and that is why those samples are in standard use.

When the strength on pressure is in determining, it is not possible to do something similar, because of stability losing phenomenon. For the result there is a strength dependence of boundary conditions samples, i.e., of geometric characteristic and Poisson's coefficient.

One of the approaches to this problem is determining experimental strength dependence on pressure in function of sample geometric characteristics for a given material.

Second approach is stress state analysis in the sample and stress global maximum determining, which is proclaimed for strength instead of average (nominal) value. In this study, stress state in pressed samples is analyzed by Finite Element Method (FEM), on assumption of material and geometric linearity. Program SAP IV has been used after supplement of program code, which gives the ability of finding maximal normal (σ_{max}) and tangential stress (τ_{max}) and also maximal tangential stress intensity (T_{max}).

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2. STATIC MODEL AND DISCRETISATION

Static model of determining strength on pressure is given on picture No. 1.

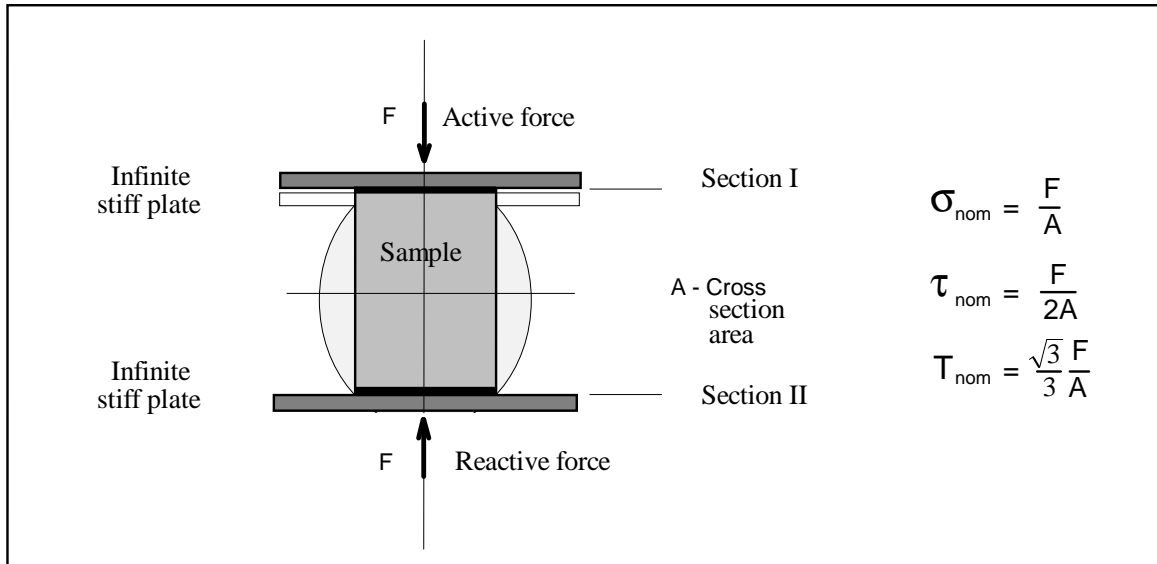


Figure 1. Static model of experimental determination of strength on pressure

Analysis presumption was that there is no slipping in sections I and II (touching surfaces of a sample and press elements). Points that belong to surfaces I and II are having the same displacements, which are normal on these surfaces.

A symmetry was used while forming FEM model, so that only one eighth of prismatic samples is discretised, and one half of cylindrical samples. Finite element meshes are given on figures No. 2 and 8. Relatively rare finite element's mesh was adopted because of a large scale of computing. In this analysis was varying Poisson's coefficient (10 values) and sample's ratio of high and cross dimension (18 values). Prismatic and cylindrical samples were considered, so total number of computer running was 360 (2*18*10).

While presenting the analysis results of a sample, geometric characteristics (h/a or h/d) are showed with logarithm scale (abscissa). Stress scales remain linear (ordinate). In all diagrams, spline approximation was performed.

3. THE RESULTS OF STRESS STATE ANALYSIS IN PRESSED PRISMATIC SAMPLES

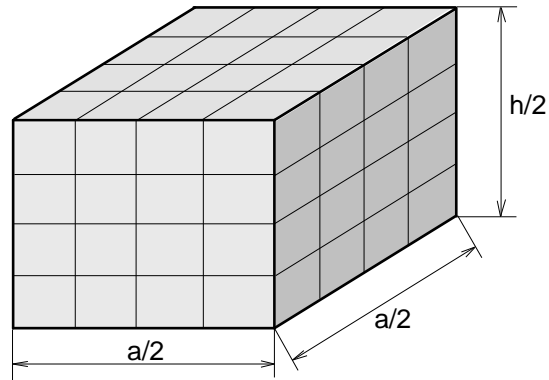


Figure 2. Finite elements mesh

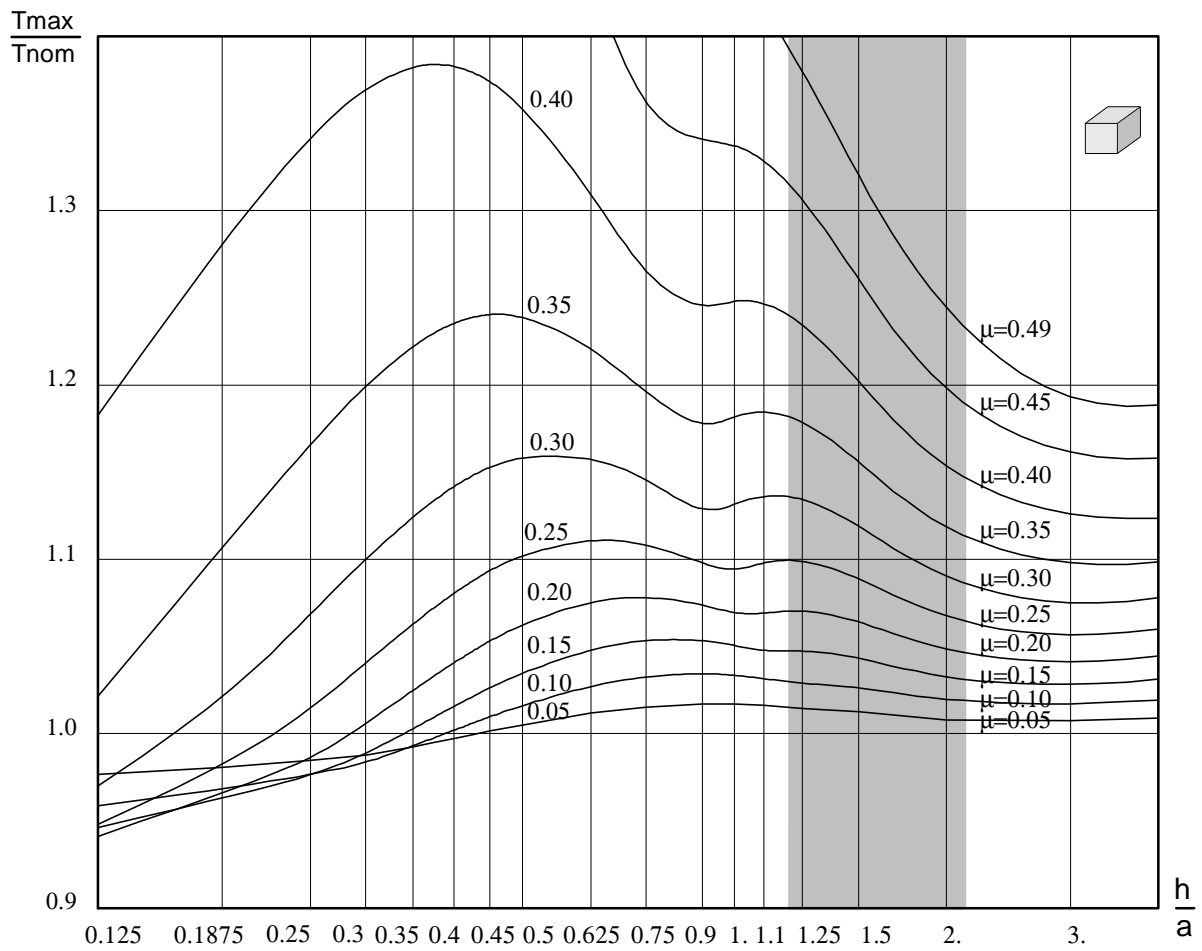


Figure 3. Normalized tangential stress intensity in function of sample's height and width ratio for various Poisson's coefficients

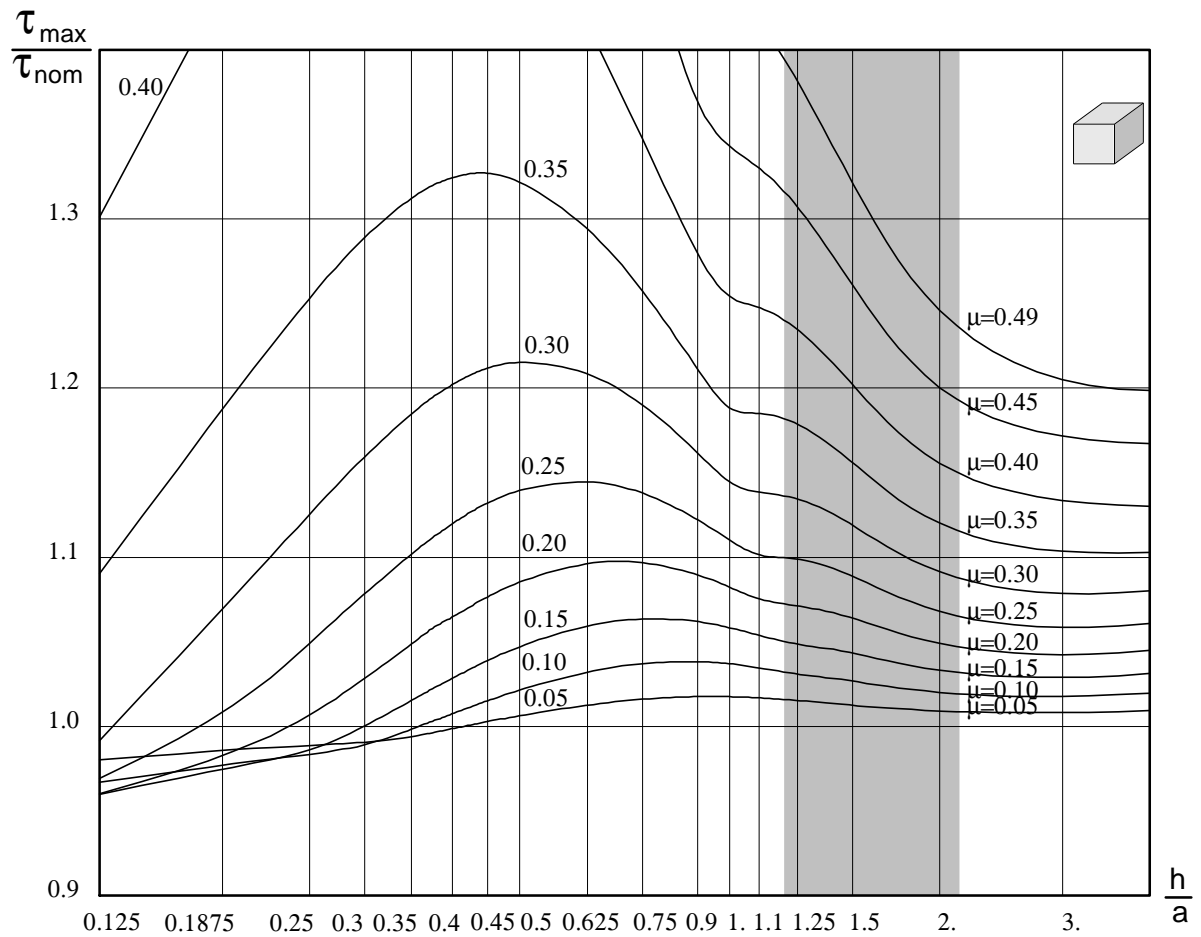


Figure 4. Normalized maximal tangential stress in function of sample's height and width ratio for various Poisson's coefficients

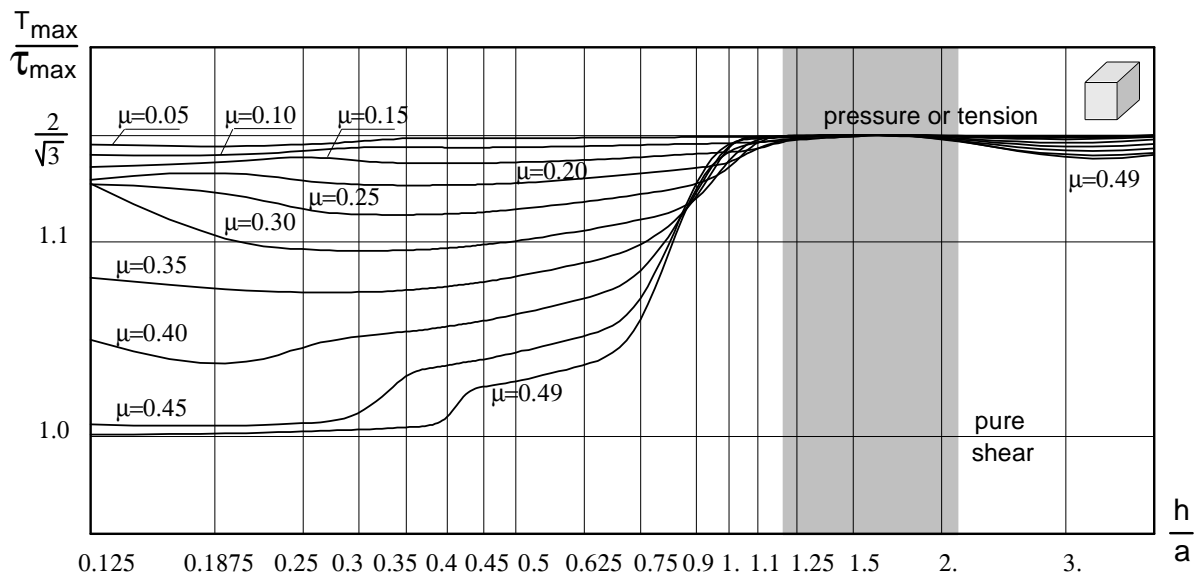


Figure 5. Comparing of maximal tangential stress intensity and maximal tangential stress for pressed prismatic samples

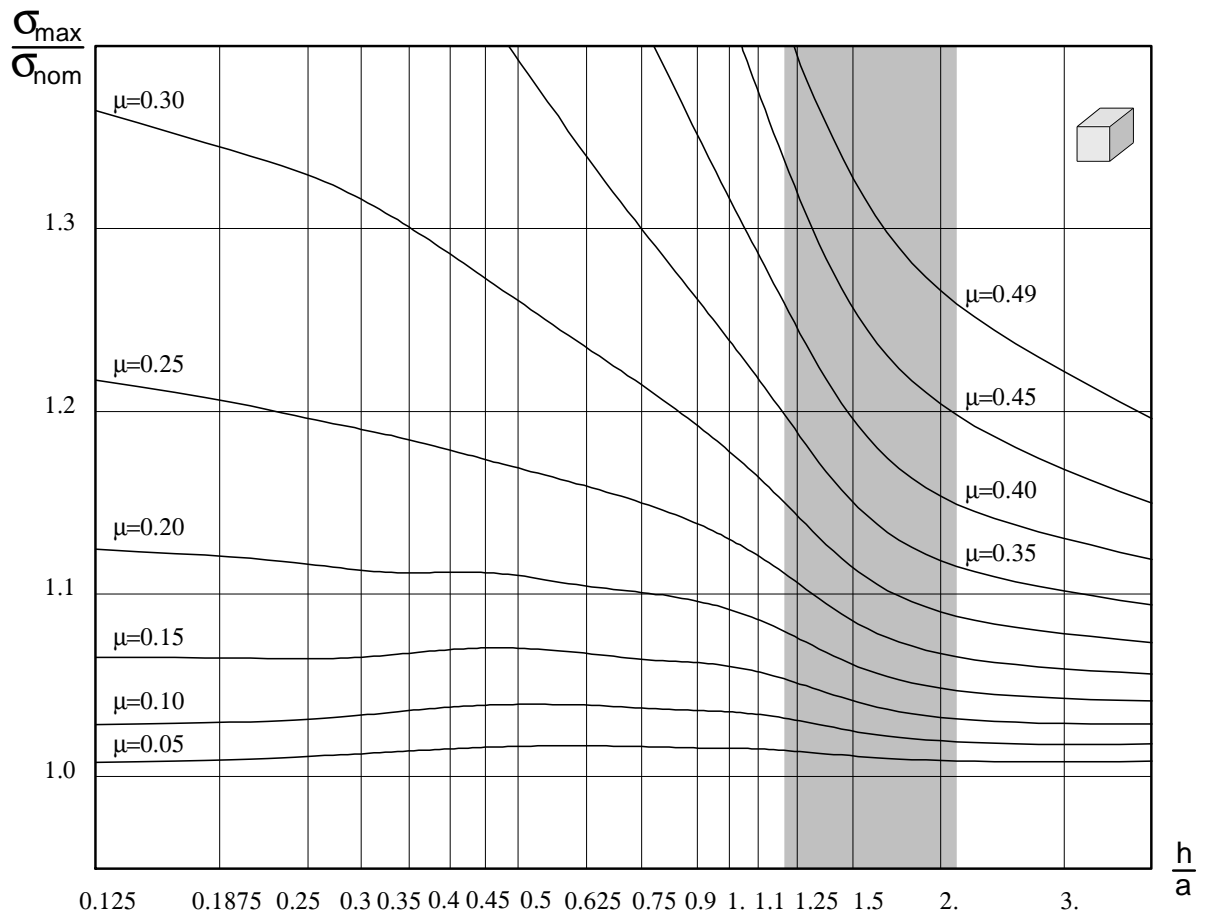


Figure 6. Normalized maximal normal stress in function of sample's height and width ratio for various Poisson's coefficients

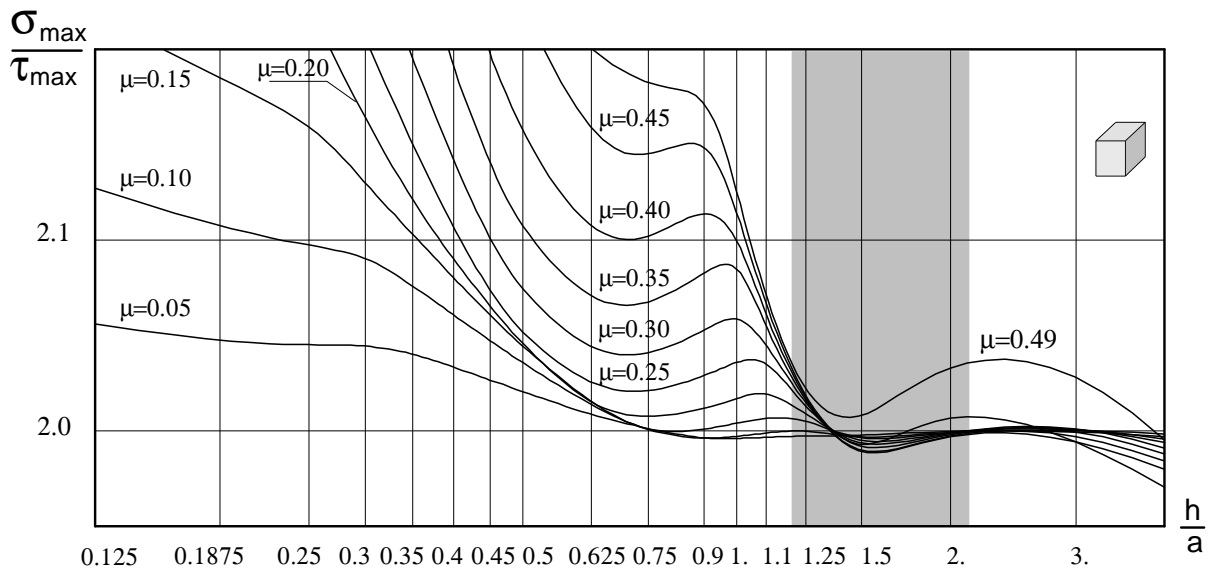


Figure 7. Comparing of maximal normal stress and maximal tangential stress for pressed prismatic samples for various Poisson's coefficients

4. THE RESULTS OF STRESS STATE ANALYSIS IN PRESSED CYLINDRICAL SAMPLES

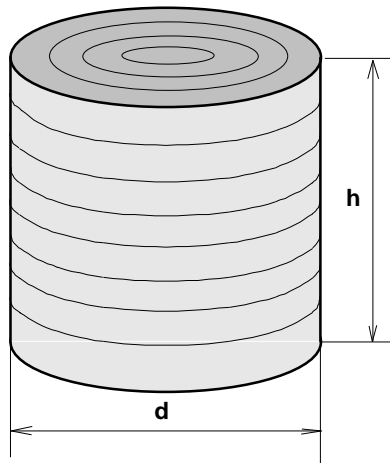


Figure 8. Axial symmetric finite elements mesh

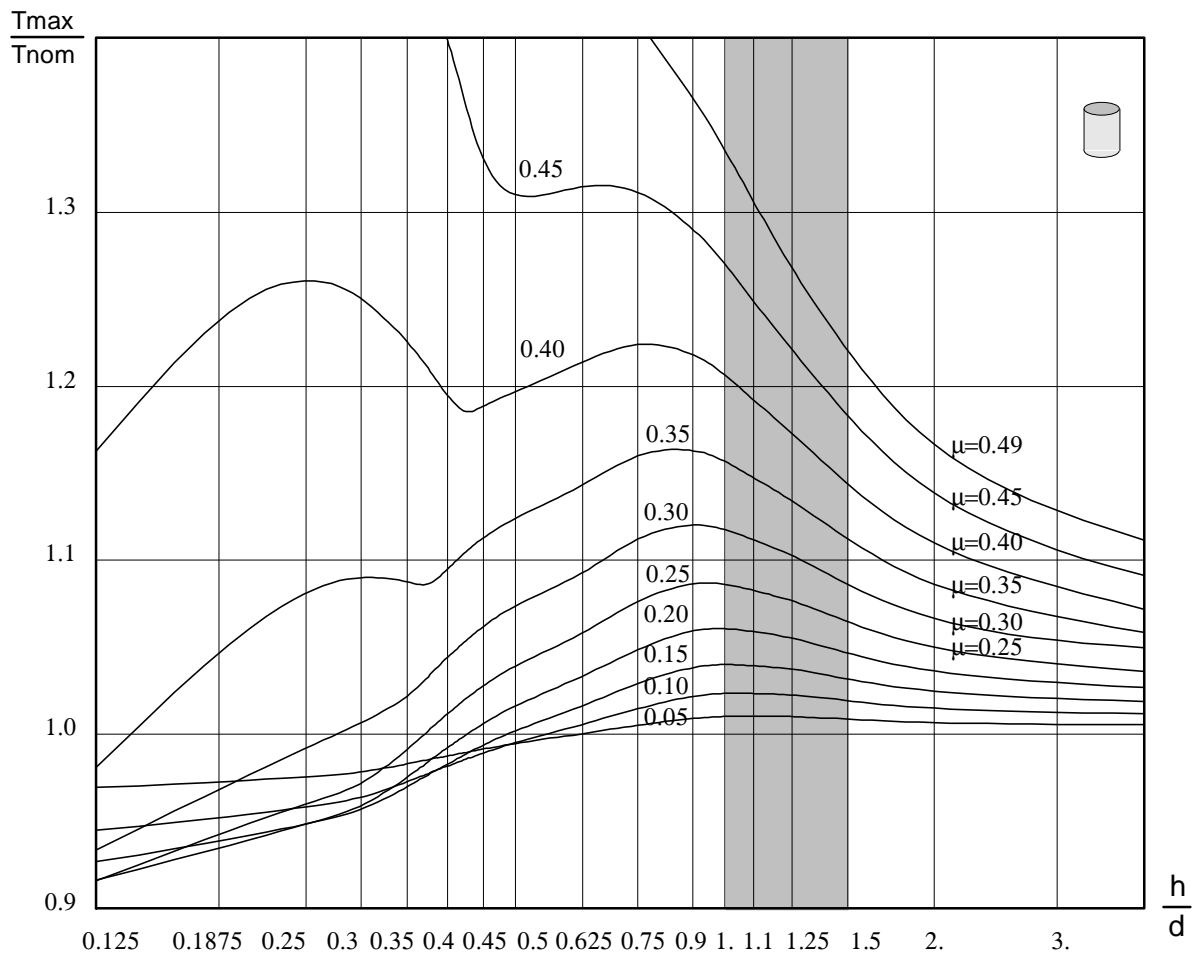


Figure 9. Normalized tangential stress intensity in function of sample's height and width ratio for various Poisson's coefficients

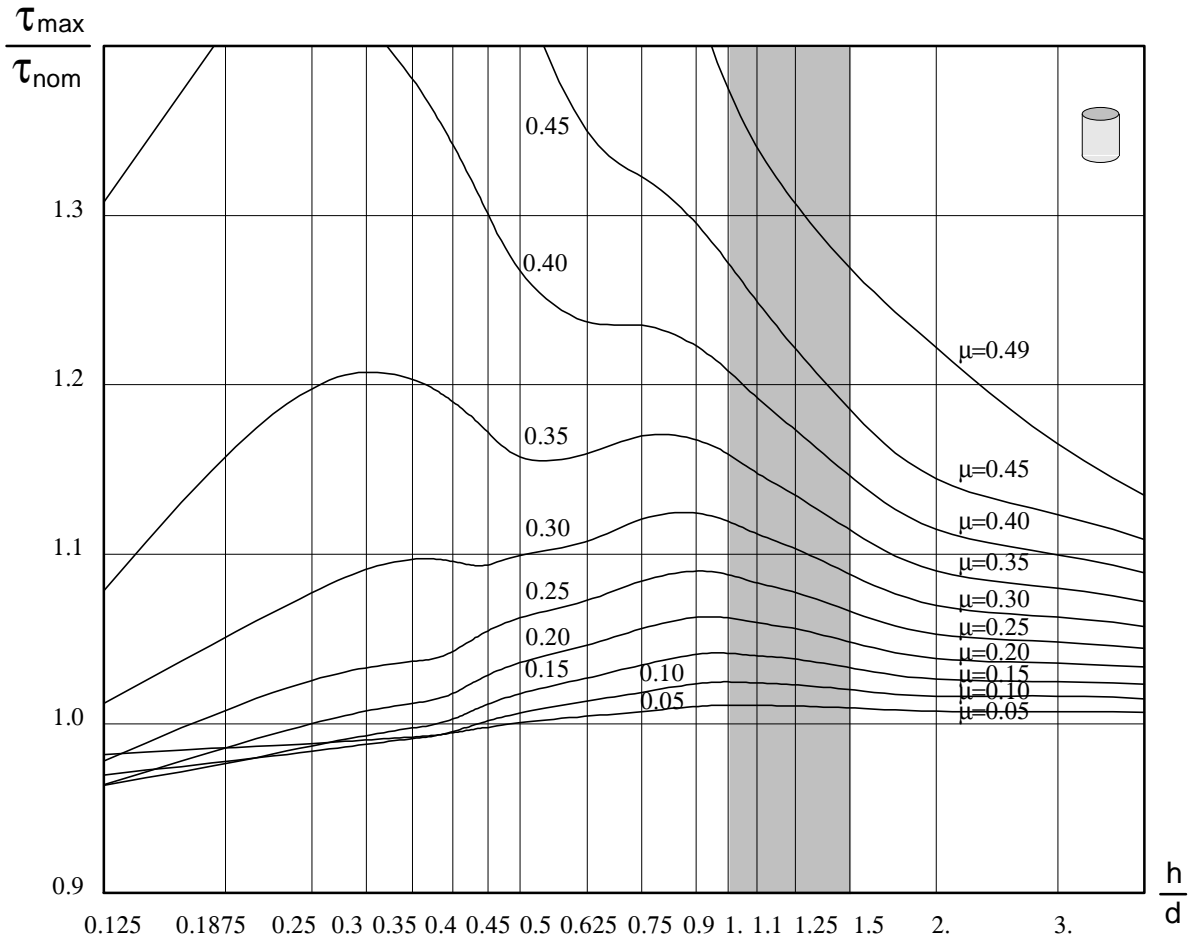


Figure 10. Normalized maximal tangential stress in function of sample's height and width ratio for various Poisson's coefficients

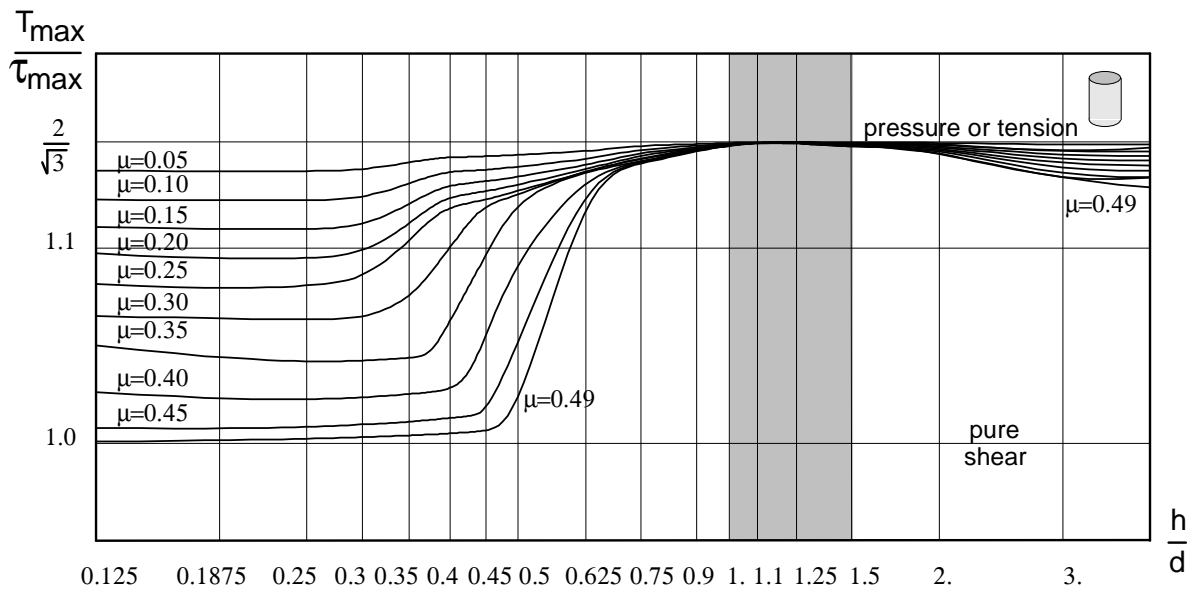


Figure 11. Comparing of maximal tangential stress intensity and maximal tangential stress for pressed cylindrical samples

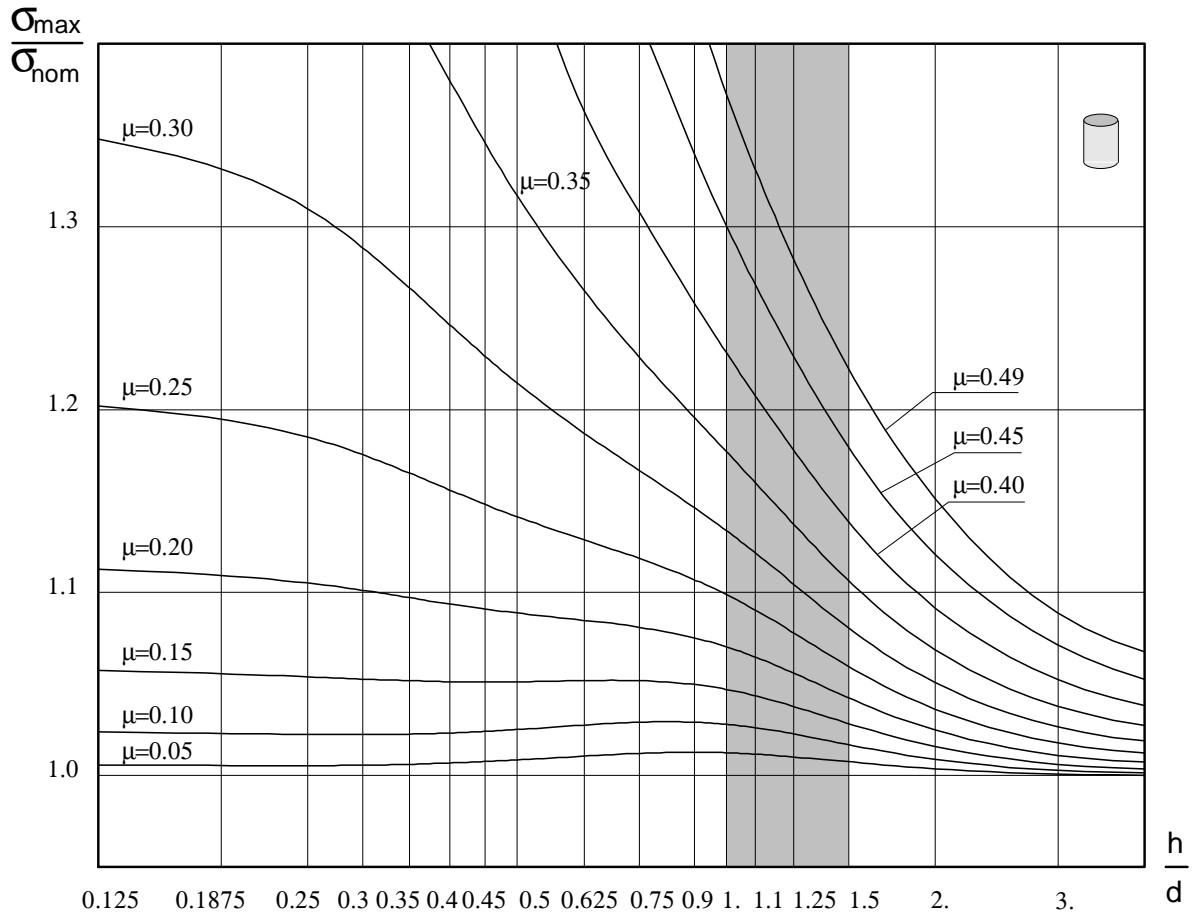


Figure 12. Normalized maximal normal stress in function of sample's height and width ratio for various Poisson's coefficients

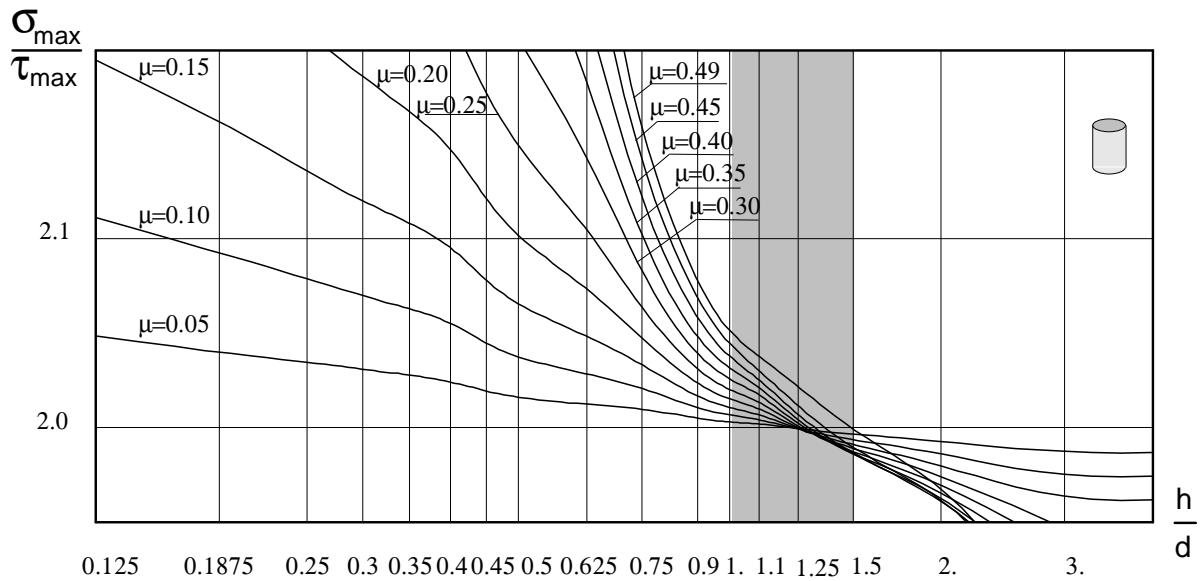


Figure 13. Comparing of maximal normal stress and maximal tangential stress for pressed cylindrical samples for various Poisson's coefficients

5. PRESSURE STRENGTH CORRECTION FACTORS

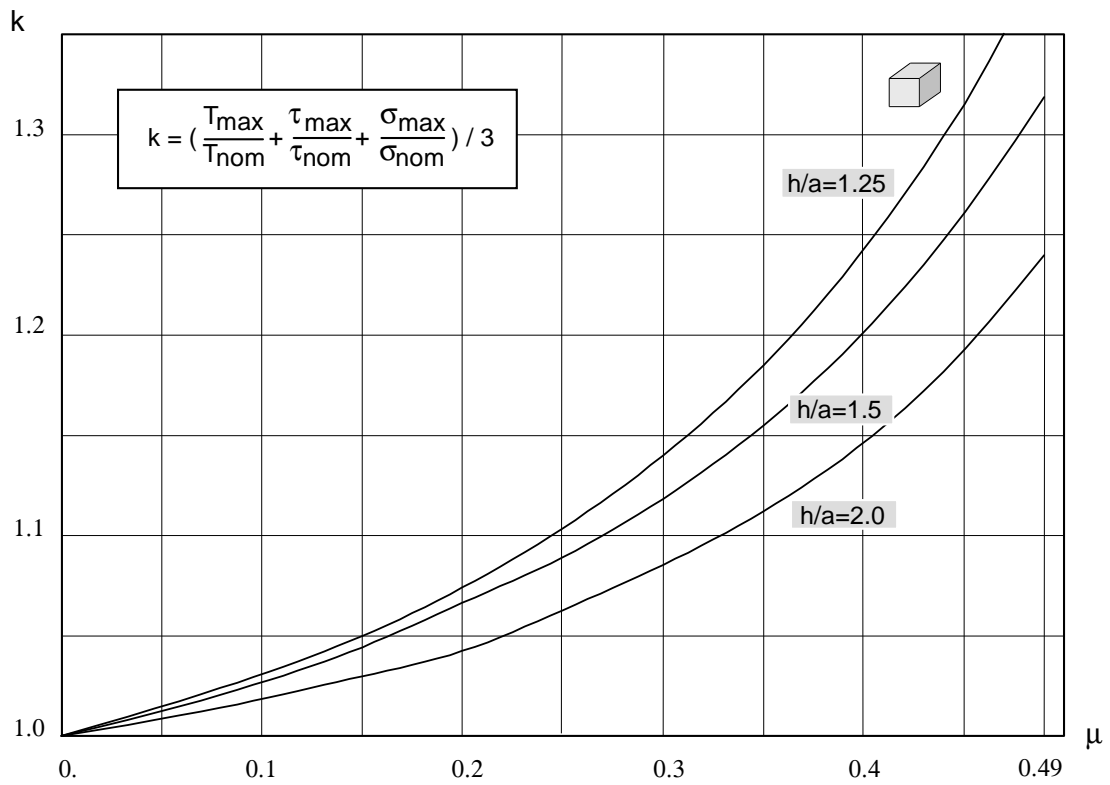


Figure 14. Average maximal normalized stresses in function of Poisson's coefficient for pressed prismatic samples

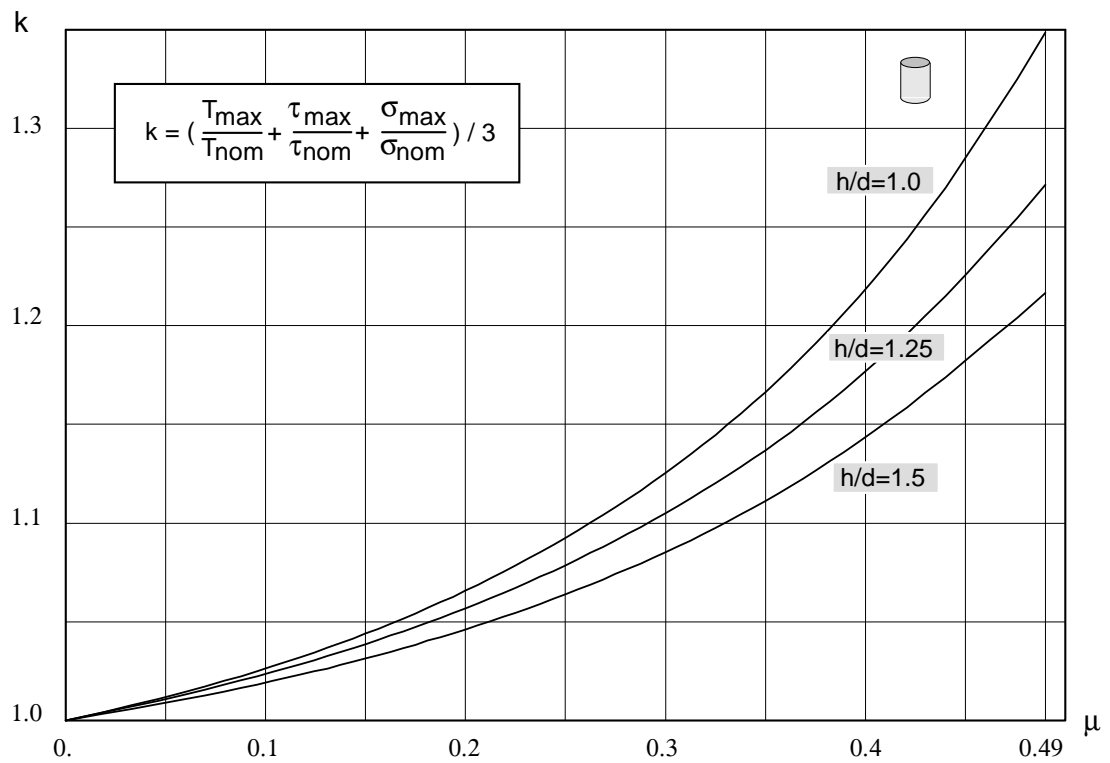


Figure 15. Average maximal normalized stresses in function of Poisson's coefficient for pressed cylindrical samples

6. CONCLUSION

T_{max}/τ_{max} ratio for pure axial stress state is $2/\sqrt{3}$ and σ_{max}/τ_{max} is equal 2 (figures 5, 7, 11 and 13). When in sample break zone could be existed really "pure pressure", that would be the ideal strength on pressure determined experiment. No matter what material is, we can approach to that ideal, if we use samples with geometric characteristics from shadowed intervals. If all model dimensions are multiply with some constant, stress state has remain unchanged.

Strength average (nominal) value on pressure should be multiply with appropriate factor given on the figures 3, 4 or 6 for prismatic and on 9, 10 or 12 for cylindrical samples. If samples from the shadowed intervals are in usage, then all three hypotheses about material break (T_{max} , τ_{max} , σ_{max}) are giving the same results. It is recommended to use samples with that geometrically characteristics. For that case diagrams for correction factors have been constructed (figures 14 and 15). Defined strength (global stress maximum) has sense, because it is compared with global stress maximum in structure (critical section). So, stress analysis in a sample was performed on the same way as it was structure.

On the occasion of valuing or using obtained results, it is necessary to take care that they are obtained under assumption of material linearity, homogeneity and isotropy. Author is hopping that displayed results would maintain experimental check.

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