Material Unistrength (Universal Material Strength Science)

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Material strength science uses nonuniversal dimensional mechanical stresses without expressing their risk (danger) degrees. For an arbitrarily anisotropic material with different resistances to tensions and compressions and for any variable loads with possibly rotating the principal directions of the stress state at a material point during loading, there are no common limiting state criteria for triaxial mechanical stresses and no universal strength laws of nature. The Tresca and Huber-von-Mises-Hencky criteria are quite nonsensitive to pressure with significant effect on strength in the Nobel prize winner Bridgman experiments and prescribe to the ratio of the tensile and shear strengths the values of 2 and $3^{1/2}$ whereas this ratio varies from 1 to 4.

Material unistrength [1-9] discovers universal stresses, or unistresses, $\sigma_j°$. For any stationary loading an arbitrarily anisotropic material, $\sigma_j° = \sigma_j/|\sigma_{Lj}|$ where σ_{Lj} is, for the usual principal stress, σ_j , its limiting value which has the direction and sign of σ_j and acts at the same material's point, the both other principal stresses vanishing, and the other loading conditions at the same point being the same. Linearly correcting an arbitrary limiting criterion $\sigma_e = F(\sigma_1 , \sigma_2 , \sigma_3) = \sigma_L$ via constant x and generalizing give

$$\sigma_e = F(\sigma_1, \sigma_2, \sigma_3) + x\sigma_2 = \sigma_L,\ \sigma_e° = F(\sigma_1°, \sigma_2°, \sigma_3°) = 1,\ \sigma_e° = F(\sigma_1°, \sigma_2°, \sigma_3°) + x\sigma_2° = 1.$$

See the limiting surfaces and lines in unordered principal stresses σ_{1u} , σ_{2u} , σ_{3u} in Figures 1, 2 for an isotropic material with equal strength in tension and compression (Figure 2 above) and with unequal strengths in tensions and compressions in the cases of isotropy (Figure 1, Figure 2 in the middle) and anisotropy (Figure 2 below):

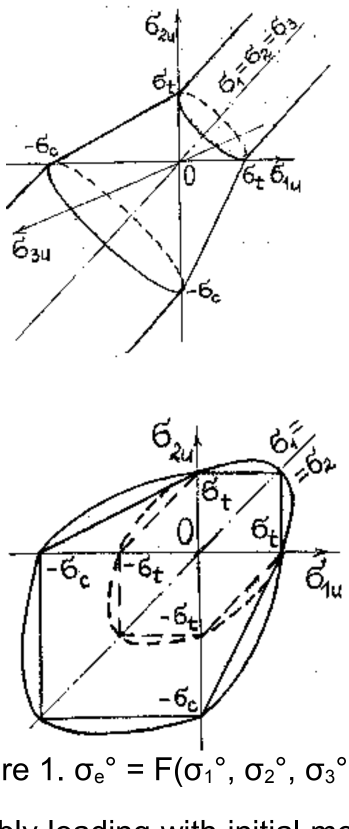

Figure 1. $\sigma_e° = F(\sigma_1°, \sigma_2°, \sigma_3°) = 1$

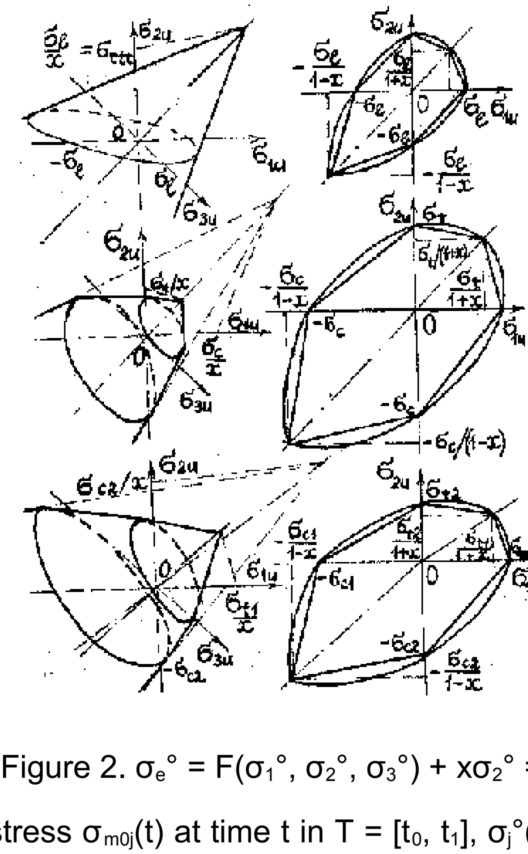

Figure 2. $\sigma_e° = F(\sigma_1°, \sigma_2°, \sigma_3°) + x\sigma_2° = 1$

For variably loading with initial mean cycle stress $\sigma_{m0j}(t)$ at time t in $T = [t_0, t_1]$, $\sigma_j°(t) = [\sigma_j(t)-\sigma_{m0j}(t)]/|\sigma_{Lj}(t)-\sigma_{m0j}(t)|$. For each uniaxial stress process, $\sigma_j(t)$, its own reserve, n_j , is defined by the similar limiting process, $n_j\sigma_j(t)$, with possibly taking damage accumulation into account. Determine the equidangerous cycle of unistresses with mean stress $\sigma_{mj}°$ and amplitude stress $\sigma_{aj}°$, then the constantly vectorial reduced unistress $\boldsymbol{\sigma}_j° = (\sigma_{mj}°, \sigma_{aj}°)$ via the limiting amplitude diagram. Now choose the most dangerous, possibly depending on t , permutations of the stationary indexes, ju, of the unordered unistresses without $\sigma_{1u}° \geq \sigma_{2u}° \geq \sigma_{3u}°$. The final universal criterion is

$$\sigma_e° = \max\{\sup_{t\in T} \max_{ju(t)} F(\sigma_{1u}°(t), \sigma_{2u}°(t), \sigma_{3u}°(t)), \max_{ju} |F(\boldsymbol{\sigma}_{1u}°, \boldsymbol{\sigma}_{2u}°, \boldsymbol{\sigma}_{3u}°)|\} = 1.$$

Material unistrength gives universal strength laws also for aeronautical fatigue.

Keywords: Ph. D. & Dr. Sc. Lev Gelimson, "Collegium" All World Academy of Sciences, Academic Institute for Creating Fundamental Sciences, Physical Journal, universal physics, uniphysics, universal measurement science, universal metrology, unimetrology, universal mathematics, perfectly sensitive unimathematics, Unimathematik, Best Data Approximation Science, classical estimation, approximation, data processing, least square method, Deformable Solid Unimechanics, Deformable solid mechanics, nonuniversal dimensional mechanical stress, danger degree risk nonexpression, Material Unistrength, Universal Material Strength Science, material strength science, arbitrarily anisotropic material, different resistance to tension and compression, variable load, possibly rotating principal stress state directions, limiting state criterion, triaxial mechanical stress, universal strength law of nature, Tresca criterion, Huber-von-Mises-Hencky criterion, pressure nonsensitivity, significant strength effect, Nobel prize winner Bridgman experiments, tensile-shear strengths ratio, prescribed value, universal stress, unistress, stationary loading, static loading, limiting value, direction, sign, material's point, loading condition, linearly correcting, limiting surface, limiting line, unordered principal stress, unequal strengths in tensions and compressions, anisotropy, variably loading, initial mean cycle stress, time, uniaxial stress process, own reserve, similar limiting process, damage accumulation, equidangerous unistress cycle, mean stress, amplitude stress, constantly vectorial reduced Unistress, limiting amplitude diagram, most dangerous stationary index permutation possibly depending on time, final universal criterion, aeronautical fatigue, Stephen Timoshenko, General Problem Theory, Elastic Mathematics, General Strength Theory, The Stress State and Strength of Transparent Elements in High-Pressure Portholes, Generalization of Analytic Methods of Solving Strength Problems for Typical Structure Elements in High-Pressure Engineering, The generalized structure for critical state criteria, Basic New Mathematics.

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