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EQUILIBRIUM PATHS OF STRETCHED AND COMPRESSED STEEL SAMPLES

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Synopsis. This paper shows quantitative and qualitative differences in equilibrium paths $S(\Delta l)$ of stretched and compressed steel samples. An analysis is made of Young's secant and plasticity moduli along all the equilibrium paths.
Diagrams of Poisson's ratio and coefficients of variation all of variables are shown. It is also shown that optimal length of compressed samples amounts to 3 diameters, to avoid stability loss during compression tests.

Many authors have noticed the qualitative difference in static equilibrium paths $S(\Delta l)$ of stretched and compressed steel bars in the elastoplastic area. This is of considerable importance for the estimation of limiting capacity of truss structures in which occur stretched and compressed steel bars. Equilibrium paths $S(\Delta l)$ of stretched steel bars exhibit quantitative and qualitative resemblance of equilibrium paths of steel samples $\sigma(\varepsilon)$.

In order to examine justness of the theoretical estimation of static equilibrium paths $S(\Delta l)$ of compressed steel bars on the basis of equilibrium paths $\sigma(\varepsilon)$ in stretched steel samples, a statistical investigation of equilibrium paths in compressed and stretched steel samples St3S was made (Fig.1). The investigation excluded the influence of strain rate on the qualitative results of measurements and Poisson's ratio $\bar{\nu}(\varepsilon)$ was determined (Fig.1). It is to be noted that Poisson's ratio does not reach a maximum value 0.5 in the plastic area.

The dimensions of compressed samples were chosen in order to eliminate buckling effect. Friction in pressure planes was eliminated by means of special solid grease (molybdenum disulfide).

A continuous line in Fig.1 represents the mean equilibrium path $\bar{\sigma}(\varepsilon)$ in a stretched steel sample with its coefficient of variability and the plot of Poisson's coefficient $\nu(\varepsilon)$. A broken line represents respective values for compressed steel samples.

Fig.2 shows the results of an analysis of shaping the deformability moduli: 1) secant modulus $E_s = \sigma_x / \varepsilon_x$ 2) tangent modulus $E_t = \partial\sigma_x / \partial\varepsilon_x$, 3) plasticity modulus $E_p = E_o E_s / (E_o - E_s)$.

It follows from a comparison of equilibrium paths in compressed steel samples with those in stretched steel samples that: 1) Modulus of elasticity is in the elastic

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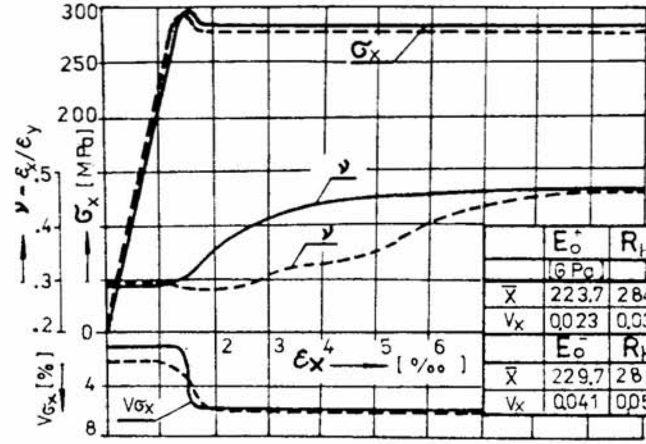
area by 2.7% greater than in stretched steel samples, 2) Limit elasticity R_H is by 1.5% smaller, 3) Upper plasticity limit R_g is by 1.3% smaller, 4) Lower plasticity limit R_d is by 1.3% smaller, 5) Plastic hold does not exhibit any sharp inequalities as in conventional tests, it is sufficiently long and approaches the straight line. Both equilibrium paths can be approximated by Prandtl's model.

The step change in the variability coefficient $V_\sigma = D_\sigma/\bar{\sigma}$ of equilibrium paths of material is a qualitatively good indicator of equilibrium loss in material.



	E_o^+	R_H^+	R_g^+	R_d^+	ε_g^+
	[GPa]	[MPa]			[‰]
$\bar{X}$	223.7	284.3	295.3	280.0	1.48
V_x	0.023	0.035	0.077	0.079	0.080
	E_o^-	R_H^-	R_g^-	R_d^-	ε_g^-
$\bar{X}$	229.7	280.1	291.6	276.3	1.34
V_x	0.041	0.058	0.060	0.079	0.070

Fig.1. Equilibrium paths and Poisson's coefficient in stretched and compressed steel samples

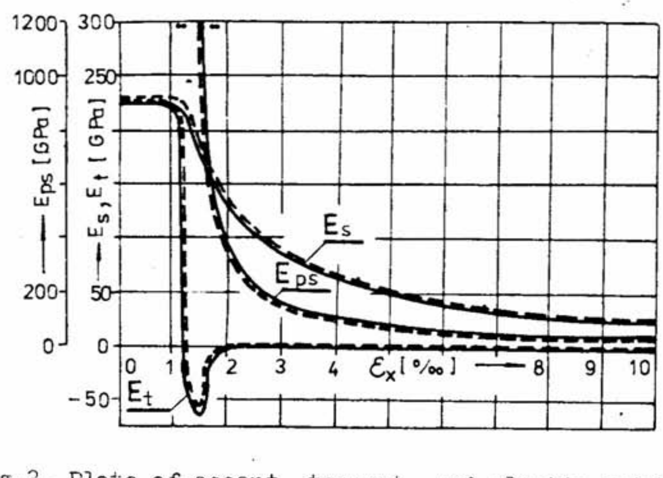


Fig.2. Plots of secant, tangent, and plastic moduli