SYMBOLS

(only the most important symbols for presentation and application of the method)

(the symbols in `Courier New` are those visualized in graph mode)

Latin

', " Principal axes of plane state of stress

A Constant in S-N line equation; constant for σ'

`A` Side of square in graph mode

a Mathematical expression in the role of coefficient of elliptic equation

a Amplitude index

`As` Addend to $s(t)$; s_{m}

B Constant for σ''

b Mathematical expression in the role of coefficient of elliptic equation

C Static center of a variant trajectory (its coordinates are $\sigma_{x,\mathrm{m}}$, $\sigma_{y,\mathrm{m}}$ and $\tau_{xy,\mathrm{m}}$)

c $-1/s^2$ in the role of coefficient of elliptic equation

`Code` `1:` $\sigma_x(t)$, $\sigma_y(t)$ and $\tau_{xy}(t)$ are entered; X-$Y \equiv \sigma'$-σ''; `Nrct=3`

`2:` $\sigma_x(t) \equiv \sigma'(t)$ and $\sigma_y(t) \equiv \sigma''(t)$ are entered; X-$Y \equiv \sigma'$-σ''; `Nrct=2`

`3:` $\sigma(t) \equiv \sigma_x(t)$ and $\tau(t) \equiv \tau_{xy}(t)$ are entered; X-$Y \equiv \sigma'$-σ''; `Nrct=3`

`4:` $\sigma(t) \equiv \sigma_x(t)$ and $\tau(t) \equiv \tau_{xy}(t)$ are entered to appear along ξ and η; `Nrct=2`

`5:` $\varepsilon_x(t)$, $\varepsilon_y(t)$ and $\gamma_{xy}(t)$ are entered; X-$Y \equiv \varepsilon'$-ε''; `Nrct=3`

`6:` $\varepsilon_x(t)$, $\varepsilon_y(t)$ and $\varepsilon_b(t)$ are entered from x-y-b rosette; X-$Y \equiv \varepsilon'$-ε''; `Nrct=3`

D Fatigue Damage; $D(s) = 1/[i^* N(s)]$ is primitive function to $R(s)$

`D` Symbol for D_Σ in graph mode

d Differential (that is numerically substituted by Δ)

d_c Ratio of damages: $d_c = D_{\Sigma,c,T}/D_{\Sigma,T}$

dD Damage differential; $\mathrm{d}D_r$ is per $\mathrm{d}s_r$; $\mathrm{d}D_c$ is per $\mathrm{d}s_c$; $\mathrm{d}D_\tau$ is per $\mathrm{d}\tau$

d_r Ratio of damages: $d_r = D_{\Sigma,r,T}/D_{\Sigma,T}$

ds Loading differential

`Ds` Devisor of $s(t)$

$\mathrm{d}s_c$ Circumferential component of $\mathrm{d}s$ and $\mathrm{d}s_{xy}$

$\mathrm{d}s_r$ Radial component of $\mathrm{d}s$ and $\mathrm{d}s_{xy}$

$\mathrm{d}s_{xy}$ Component of $\mathrm{d}s$ in X-Y plane

D_T Damage per a cycle within T

D_{Σ} Cumulative (current) damage.

$D_{\Sigma,\mathrm{cr}}$ Critical accumulated damage ($D_{\Sigma,\mathrm{cr}} = 1$ in this thesis)

$D_{\Sigma,c,T}$ Damage accumulated in T as a sum of differentials ΔD_c

$D_{\Sigma,r,T}$ Damage accumulated in T as a sum of differentials ΔD_r

$D_{\Sigma,T}$ Damage totally accumulated in T as a sum of differentials ΔD

$D_{\Sigma,\tau,T}$ Damage accumulated in T as a sum of differentials ΔD_{τ}

$\mathrm{d}\tau$ Component of $\mathrm{d}s$ perpendicular to the σ'-σ'' plane.

d_{τ} Ratio of damages: $d_{\tau} = D_{\Sigma,\tau,T}/D_{\Sigma,T}$.

E Young modulus

f Ratio $f = R/R_r$ in case a single R-intensity is used

f_c Factor of (sensitivity of the material to) loading non-proportionality (associated with immovability of the principal axes): $f_c = R_c/R_r$

f_{τ} Factor of (sensitivity of the material to) loading non-proportionality (associated with rotation of the principal axes): $f_{\tau} = R_{\tau}/R_r$

i Counter of the input prototypes, $\mathrm{i} = 1, 2, \ldots, n$; counter of the addends of sums

`i` Counter of the trajectory elements in graph mode; counter for other purposes

i^*, `i*` Divisor for static (mean) stress, respectively for loading asymmetry

`j` Number of trajectory elements to be displayed in a group; counter for other purposes

k, `k` Ratio $k(t) = Y(t)/X(t)$; $k(t)$ is mostly $\sigma''(t)/\sigma'(t)$; $k = \mathrm{const}$ under one-component or proportional loading and for an input R-prototype

k_{i} k for i^{th} input R-prototype (one of its parameters, see also $\sigma'_{\mathrm{max,i}}$)

L No-damage area (with $R = 0$) in the X-Y plane; the curved limiting line surrounding that area; L is particularly L_r (or L_l) for $R_r = 0$, L_c for $R_c = 0$ and L_{τ} for $R_{\tau} = 0$; the L line is a limiting l_N line of equal life $N \equiv N_{\mathrm{ex}}$

$_l$ Index of limit (or of fatigue failure locus, etc.)

$l_{\mathrm{equ,m}}$ Line of equal equivalent mean (static) stress $\sigma_{\mathrm{equ,m}}$

L_{min} Absolute smallest no-damage area.

l_N Line of equal life N (from R_r-prototypes) under cyclic proportional or one-component loadings (cyclic r-loadings)

`Ln` Life name in graph mode

m, `m` (Indicator of) slope of an S-N line

$_{\mathrm{m}}$ Mean (static) stress index

$_{\mathrm{max}}$ Index of maximum of stress cycle or maximum in a oscillogram `maxX` Fixes the right side of the square in graph mode

m_{i} m of i[th] input R-prototype (one of its parameters, see also $\sigma'_{\mathrm{max,i}}$)

$_{\mathrm{min}}$ Index of minimum of stress cycle or minimum in a oscillogram

`minX` Fixes the left side of the square in graph mode

`minY` Fixes the lower side of the square in graph mode

m_l, `Ml` Multiplier of life

`Ms` Multiplier of $s(t)$

N Life as a number of repetitions of T to fatigue failure: $N = 1/D_{\Sigma,T}$; number of cycles to failure, function $N(s) \equiv N(s_{\mathrm{max}})$; abscissa of a point of an S-N line

n, `n` Number of input prototypes, $2 \leq n \leq 9$; number of input ordinates of $s(t)$ to be processed by *Integral* program; fatigue safety factor

`n1` Serial number of first series to be processed by *EllipseS* program

`n2` Serial number of last series to be processed by *EllipseS* program

N_c Number of cycles (see also N_{ex}) for forming the limiting line (the no-damage area) L_c

N_{cmp} Computed life

N_{ex} Extrapolated number of cycles; it may be $N_{\mathrm{ex},r}$, $N_{\mathrm{ex},c} \equiv N_c$ and $N_{\mathrm{ex},\tau} \equiv N_\tau$; $N_{\mathrm{ex},r}$ may be N_r in smooth mode or N_l in breaking mode

`Nex` See N_{ex}

N_{exp} Experimental life

N_{i} Abscissa of through-point of i[th] input R-prototype (see also $\sigma'_{\mathrm{max,i}}$)

n_i, `Ni` Number for interpolation; in *EllipseT*, n_i can be 1, 2, 3, 4, 6, 8, 12, 24 (24 is divisible by these values); in *EllipseS*, n_i can be any integer greater than 0; $n_i = 1$ means no interpolation

N_l, `Nl` Number of cycles at the break of S-N line; serves for forming the limiting line (the no-damage area) L_l (in breaking mode)

N_r Number of cycles (see also N_{ex}) for forming the limiting line (the no-damage area) L_r (in smooth mode)

`Nrct` Number of R functions: `3`, the R functions are R_r, R_c and R_τ; or `2`, the R functions are R_r and R_c; see also `Code`

n_v, `Nv` Number of values in a series for interpolation

N_τ Number of cycles (see also N_{ex}) for forming the limiting line (the no-damage area) L_τ

p_{i} Relative statistical frequency of within a Δs_{i} interval

p_{ij} Relative statistical frequency of appearing Δs elements within an (i,j) cell

q_k Quotient (ratio) $\sigma'_{\mathrm{m}}/\sigma_{\mathrm{equ,m}}$ at given k at $l_{\mathrm{екв,m}}$ line; $q_k = \sigma'_k/\sigma'_{k=0}$ at l_N line

R Damage intensity, R function of σ' and σ'' (or of ε' and ε'', etc.); $R(s) = \mathrm{d}D(s)/\mathrm{d}s$ is derivative function to $D(s)$; in particular, R is R_r, R_c, R_τ

R Stress ratio: $\mathrm{R} = s_{\max}/s_{\min}$

R_c Damage intensity at $\mathrm{d}s_c$

$\mathrm{R_m}$ (Ultimate) static strength measure (σ_U)

$\mathrm{R_{p0,2}}$ Yield strength measure (σ_Y)

R_r Damage intensity at $\mathrm{d}s_r$

R_τ Damage intensity at $\mathrm{d}\tau$

S, `S` Stress; sum of Δs elements ($\mathrm{d}s$ differentials), length of (S) trajectory

s, `s` Stress; distance from the coordinate origin to the running point of a trajectory, argument of $R(s)$ and $D(s)$

(S) Invariant trajectory consisting of Δs elements ($\mathrm{d}s$ differentials).

S_c Sum of Δs_c elements ($\mathrm{d}s_c$ differentials), length of (S_c) trajectory

(S_c) Trajectory consisting of Δs_c differentials ($\mathrm{d}s_c$ differentials)

s_l, `Sl` Fatigue limit ($s_l \equiv s_{\max,l}$)

s_r, `Sr` Limit to which an R_r prototype is extrapolated in smooth mode

S_r Sum of Δs_r elements ($\mathrm{d}s_r$ differentials), length of (S_r) trajectory

(S_r) Trajectory consisting of Δs_r elements ($\mathrm{d}s_r$ differentials)

S_{xy} Sum of Δs_{xy} elements ($\mathrm{d}s_{xy}$ differentials), length of (S_{xy}) trajectory

(S_{xy}) Trajectory in X-Y plane (that is mostly σ'-σ'' plane) consisting of Δs_{xy} elements ($\mathrm{d}s_{xy}$ differentials)

S_τ Sum of $\Delta\tau$ elements ($\mathrm{d}\tau$ differentials), length of (S_τ) trajectory

(S_τ) Trajectory consisting of $\Delta\tau$ elements ($\mathrm{d}\tau$ differentials)

T Time interval representative for the loading; period, cycle

t Time

t_c Trajectory ratio S_c/S

t_r Trajectory ratio S_r/S

t_τ Trajectory ratio S_τ/S

v_i Axis of an ellipse giving its arc for composition of a line of equal life by involving input prototypes with indexes $_\mathrm{i}$ and $_\mathrm{i+1}$

x, y Variant (non-principal) axes of plane state of stress

X,Y Common symbols for the axes of the coordinate plane of trajectory (S_{xy}); mostly, $X \equiv \sigma'$, $Y \equiv \sigma''$; see also `Code`; coordinates of current point of (S_{xy}) trajectory

`X,Y` See X, Y

X_0, Y_0 Coordinates of previous point of (S_{xy}) trajectory

`Xo,Yo` See X_0, Y_0

Greek

α Angle measured from x at which an infinitesimal cuboid is orientated

α_0 Angle of orientation of the principal cuboid; $\alpha_0 = \alpha'$ if α' is within the interval (-45^0, $+45^0$) and $\alpha_0 = \alpha''$ if α'' is within the interval ($+45^0$, -45^0)

α' The angle at which the principal axis ' always is

α'' The angle at which the principal axis '' always is

γ Shear strain

$\overset{*}{\gamma}_{xy}$ $\overset{*}{\gamma}_{xy} = \gamma_{xy}/2$

Δ Finite difference substituting d differential; short straight-line segment (element)

δ Initial phase angle; phase-shift angle; out-of-phase angle

$\Delta\tau$ Component of Δs perpendicular to the σ'-σ'' plane

ε Normal strain

ε', ε'' Principal strains

η The bisector of the quadrants I and III of equal algebraic signs; coordinate (along the η axis) of the invariant (principal) point (σ',σ''): $\eta = (\sigma' + \sigma'')/\sqrt{2}$

ν Poisson ratio

ξ The bisector of the quadrants II and IV of opposite algebraic signs; coordinate (along the ξ axis) of the invariant (principal) point (σ',σ''): $\xi = (\sigma' - \sigma'')/\sqrt{2}$

ξ^* $\xi^* = (\sigma' - \sigma'')/2$ or $\xi^* = (\varepsilon' - \varepsilon'')/2$

ξ^*_{v} $\xi^*_{\mathrm{v}} = (\sigma_x - \sigma_y)/2$ or $\xi^*_{\mathrm{v}} = (\varepsilon_x - \varepsilon_y)/2$

ρ Two-dimensional or one-dimensional density of an (S) trajectory; two-dimensional density (spectrum) of joint (mutual) distribution of the instantaneous (current) values of $X(t)$ and $Y(t)$; one-dimensional density (spectrum) of distribution of the instantaneous (current) values of $s(t)$

ρ_{ij} $\rho_{\mathrm{ij}} = p_{\mathrm{ij}}/(\Delta X.\Delta Y)$ is discrete two-dimensional density

σ Normal stress; σ_x, σ_y and τ_{xy} are the three stresses on a variant cuboid, and are the coordinates of the running (current) point of the variant trajectory in the σ_x-σ_y-τ_{xy} coordinate space

σ_{-1} Fatigue limit of reversed stress cycle of uniaxial state of stress

σ', σ'' Principal stresses; coordinates of running (current) point of (S_{xy}) trajectory

$\sigma'_{\max,i}$ Ordinate of through-point of i[th] input R-prototype $(\sigma'_{\max}, N, m, k, \psi)_i \equiv (\sigma'_{\max,i}, N_i, m_i, k_i, \psi_i)$ against the abscissa N_i, and the prototype is an S-N line having the equation $\sigma'^{\,m_i}_{\max} N = \sigma'^{\,m_i}_{\max,i} N_i$

σ'_p, σ''_p Coordinates of previous (preceding, old) point of (S_{xy}) trajectory

σ_{equ} Equivalent stress

$\sigma_{equ,m}$ Equivalent static (mean) stress (equivalent to $\sigma_{x,m}$, $\sigma_{y,m}$ and $\tau_{xy,m}$)

σ_U (Limit of) ultimate (static) strength (R_m)

σ_Y (Limit of) yield (static) strength ($R_{p0,2}$)

τ Shear stress (see also σ)

τ_{-1} Fatigue limit of reversed stress cycle of pure shear

τ_U (Limit of) ultimate (static) pure shear strength

τ_Y (Limit of) yield (static) pure shear strength

ψ_i Angle of deviation of v_i from η, $-45^0 < \psi_i < 45^0$, one of the parameters of i[th] input R-prototype (see also $\sigma'_{\max,i}$)

Ω The least possible area of the plane X-Y (σ'-σ'' etc.) from which a concrete invariant (S) trajectory does not go out

ω Angular frequency; angular velocity