File: Symbols.doc
Date: 2002-09-10

FEMIX 4.0

LIST OF SYMBOLS

Note: a vector is stored in a column matrix

Example: $\underline{x} = (x_1, x_2, x_3) = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = [x_1 \quad x_2 \quad x_3]^T$

L	Length
S	Surface
V	Volume
h	Thickness of the finite element or cross-section height
A	Cross-section area
I	Moment of inertia of a cross section
ρ	Mass per unit volume
γ	Weight per unit volume
α	Coefficient of thermal expansion
E	Modulus of elasticity or Young's modulus
ν	Poisson's ratio
G	Shear modulus
R	Reaction
θ	Rotation
T	Temperature
ΔT	Temperature variation
t	Time
Δt	Time step
m	Number of directions (1, 2 or 3)
n	Number of nodes of a finite element
i	Finite element node: $i=1,\cdots,n$
j	Index of a direction (global coordinate system): $j=1,\cdots,m$
k	Index of a direction (local coordinate system): $k=1,\cdots,m$
x	Cartesian coordinates of a point: $\underline{x}=(x_1, x_2, x_3)$
$\hat{e}_j$	Unit vector of the direction x_j $\hat{e}_1$, $\hat{e}_2$ and $\hat{e}_3$ define the global coordinate system (S)
$\hat{e}'_j$	Unit vector of the direction x'_j $\hat{e}'_1$, $\hat{e}'_2$ and $\hat{e}'_3$ define the coordinate system (S')
$\hat{n}$	Unit vector defining a direction: $\underline{\hat{n}}=(n_1, n_2, n_3)$
u	Displacement field: $\underline{u}=(u_1, u_2, u_3)$; $u_i=u_i(x_1, x_2, x_3)$
ε	Vector of strains: $\underline{\varepsilon}=(\varepsilon_1, \varepsilon_2, \varepsilon_3, \gamma_{23}, \gamma_{31}, \gamma_{12})$ (ε : normal strains; γ : shear strains)

σ	Vector of stresses: $\underline{\sigma}=(\sigma_1,\sigma_2,\sigma_3,\tau_{23},\tau_{31},\tau_{12})$ (σ : normal stresses; τ : shear stresses)
D	Elasticity matrix $(\underline{\sigma}=\underline{D}\,\underline{\varepsilon})$
g	Gravity acceleration: $\underline{g}=(g_1,g_2,g_3)$
Q	Externally applied concentrated load: $\underline{Q}=(Q_1,Q_2,Q_3)$
p	Distributed load per unit length: $\underline{p}=(p_1,p_2,p_3)$
q	Distributed load per unit area: $\underline{q}=(q_1,q_2,q_3)$
b	Body forces per unit volume: $\underline{b}=(b_1,b_2,b_3)$
T	Transformation matrix: $\underline{x}'=\underline{T}\,\underline{x}$ ($\underline{x}$ is in the global coordinate system) $\begin{bmatrix} x_1' \\ x_2' \\ x_3' \end{bmatrix}=\begin{bmatrix} T_{11} & T_{12} & T_{13} \\ T_{21} & T_{22} & T_{23} \\ T_{31} & T_{32} & T_{33} \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$
$\bar{x}$	Matrix of the cartesian coordinates of the nodes of a finite element $\bar{x}_{ij}$: cartesian coordinate (node i ; direction x_j) $\underline{\bar{x}}=\begin{bmatrix} \bar{x}_{11} & \bar{x}_{12} & \bar{x}_{13} \\ \bar{x}_{21} & \bar{x}_{22} & \bar{x}_{23} \\ \vdots & \vdots & \vdots \\ \bar{x}_{n1} & \bar{x}_{n2} & \bar{x}_{n3} \end{bmatrix}$
a	Vector of the nodal displacements of a finite element a_{ij} : displacement component (node i ; direction x_j) $\underline{a}=(a_{11},a_{12},a_{13},a_{21},a_{22},a_{23},\ldots,a_{n1},a_{n2},a_{n3})$
K	Stiffness matrix of the structure (global coordinate system)
K_g	Stiffness matrix of the element (global coordinate system)
K_l	Stiffness matrix of the element (local coordinate system)
F	Load vector of the structure (global coordinate system)
F_g	Load vector of the element (global coordinate system)
F_l	Load vector of the element (local coordinate system)
a	Displacement vector of the structure (global coordinate system) $(\underline{K}\,\underline{a}=\underline{F})$
a_g	Displacement vector of the element (global coordinate system) $(\underline{K}_g\,\underline{a}_g=\underline{F}_g)$
a_l	Displacement vector of the element (local coordinate system) $(\underline{K}_l\,\underline{a}_l=\underline{F}_l)$
s	Natural (curvilinear) coordinates: $\underline{s}=(s_1,s_2,s_3)$
$\bar{s}$	Matrix of the local coordinates of the nodes of a finite element $\bar{s}_{ik}$: local coordinate (node i ; direction s_k) $\underline{\bar{s}}=\begin{bmatrix} \bar{s}_{11} & \bar{s}_{12} & \bar{s}_{13} \\ \bar{s}_{21} & \bar{s}_{22} & \bar{s}_{23} \\ \vdots & \vdots & \vdots \\ \bar{s}_{n1} & \bar{s}_{n2} & \bar{s}_{n3} \end{bmatrix}$
n_{GP1}	Number of Gauss points (s_1 direction)

n_{GP2}	Number of Gauss points (s_2 direction)
n_{GP3}	Number of Gauss points (s_3 direction)
z_1	Index of the Gauss point (s_1 direction): $z_1 = 1, \cdots, n_{GP1}$
z_2	Index of the Gauss point (s_2 direction): $z_2 = 1, \cdots, n_{GP2}$
z_3	Index of the Gauss point (s_3 direction): $z_3 = 1, \cdots, n_{GP3}$
L	Strain operator: $\underline{L} = [\ldots, d/d\, x_i, \ldots]$
N_V	Vector of the shape functions: $\underline{N}_V = (N_1, N_2, \cdots, N_n)$; $N_i = N_i(s_1, s_2, s_3)$
N	Matrix of the shape functions: $\underline{N} = [\cdots, N_i, \cdots]$; $N_i = N_i(s_1, s_2, s_3)$
B	Deformation matrix $(\underline{\varepsilon} = \underline{B}\, \underline{a})$ $(\underline{B} = \underline{L}\, \underline{N})$
J	Jacobian matrix: $J_{jk} = d\, x_j / d\, s_k$
n_F	Number of nonprescribed (free) degrees of freedom of the mesh
n_P	Number of prescribed degrees of freedom of the mesh
n_T	Total number of degrees of freedom of the mesh $(n_T = n_F + n_P)$
n_e	Number of degrees of freedom of the element