$\Omega \in$
R^{n_d}
Γ
n_d
Γ_t
Γ_g
$\Gamma_t \cup$
$\Gamma_g =$
Γ
$\Gamma_t \cap$
$\Gamma_g =$
$\{ \nabla \cdot \sigma + b = 0 \text{in } \Omega \sigma \cdot n = t \text{on } \Gamma_t u = g \text{on } \Gamma_g$
(1)
σ
$\sigma(u) = 3\kappa\varepsilon^v(u) + 2\mu\varepsilon^d(u)$
(2)
ε^v
ε^d
ε

$$\varepsilon^v(u) = \frac{1}{3}\nabla \cdot u \; 1, \varepsilon^d(u) = \frac{1}{2}(u\nabla + \nabla u) - \varepsilon^v, \varepsilon^v : \varepsilon^d = 0$$

(3)
$1 =$
$\delta_{ij} e_i \otimes$
e_j
κ
μ
E
ν

$$\kappa = \frac{E}{2(1-2\nu)}, \mu = \frac{E}{2(1+\nu)}$$

(4)
b
Ω
t
g
u
$u \in$
V

$$\int_\Omega 2\mu\delta\varepsilon^d : \varepsilon^d d\Omega + \int_\Omega 3\kappa\delta\varepsilon^v : \varepsilon^v d\Omega = \int_{\Gamma_t} \delta u \cdot t d\Gamma + \int_\Omega \delta u \cdot b d\Omega, \forall \delta u \in V$$

(5)
V
$V =$
$\{v \in$
$H^1(\Omega)^2 \mid v =$
$g, \text{ on } \Gamma_g\}$
δu
u
$\delta\varepsilon^v$
$\delta\varepsilon^d$
δu
Ω
$\{x_I\}_{I=1}^{n_u}$
?
n_u
x_I
$u_h, \delta u_h$

$$u_h(x) = \sum_{I=1}^{n_u} N_I(x) u_I, \delta u_h(x) = \sum_{I=1}^{n_u} N_I(x)\delta u_I$$

(6)
N_I
u_I
x_I
$_h to weak form of Eq. weak_p enalty leads to the following Ritz-$
$Galerkin problem:$
$Find_h \in$
V_h

$$\int_\Omega 2\mu\delta\varepsilon_h^d : \varepsilon_h^d d\Omega + \int_\Omega 3\kappa\delta\varepsilon_h^v : \varepsilon_h^v d\Omega = \int_{\Gamma_t} \delta u_h \cdot t d\Gamma + \int_\Omega \delta u_h \cdot b d\Omega, \forall \delta u_h \in V_h$$

(7)
$V_h \subseteq$
V

$$V_h = \{v_h \in (\text{span}\{N_I\}_{I=1}^{n_u})^2 | v^h = g, \text{ on } \Gamma_g\}$$

(8)
δu_h
δu_I
$(2\mu K^d + 3\kappa K^v) d^u = f$
(9)
K^v
K^d

$$K_{IJ}^v = \int_\Omega B_I^{vT} B_J^v d\Omega$$

(10)
$K_{IJ}^d = \int_\Omega B_I^{dT} B_J^d d\Omega$