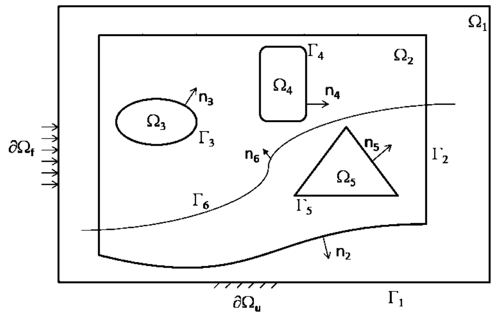
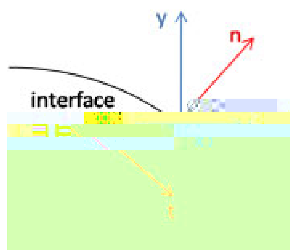


Figure 1. Ge[illegible]a[illegible]



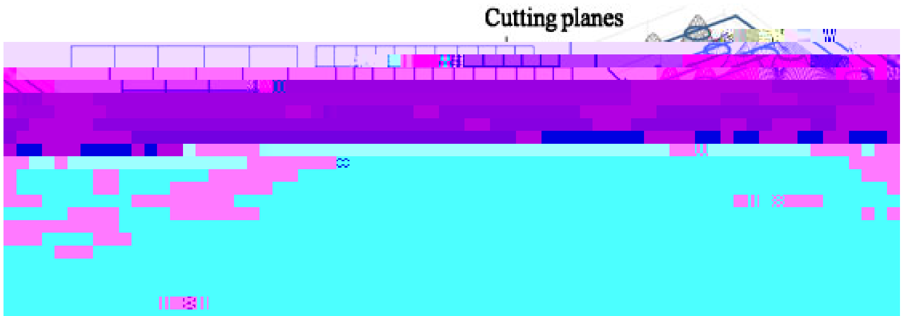


Figure 3. (a) E c ed d b face ( ); (b) c ed d a d c c ed f ac ed face; a d (c) fi c a d a d c a c a a d a .

$$N_I(\ ) = \begin{bmatrix} N_I(\ ) & 0 \\ 0 & N_I(\ ) \end{bmatrix} \quad (17)$$

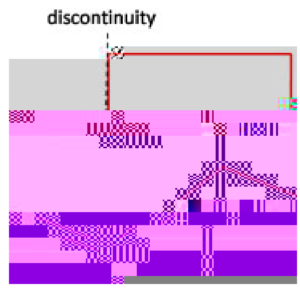
fi c $N_I(\ )$ a fi c a c a ed d I. $N_J(\ )$ a fi c a c a ed d f a a b b face (Figure 3(b)) a d $H(\ )$ a d $\chi(\ )$ a c fi c d d c d fi c a d H a d fi c , c [32, 33]). I E a (16), n a b f d , a m b f c ed d ($m \leqslant n$). B d , a c ed d b a a b face a d c ed Figure 3. T d f face a a fa , d c a fi c $\phi(\ )$ c a face d d b c f a a , a d c ed Figure 3(c). W d , f ϕ d f d c . A a ac f a f a c face d d b ad f fi c $\phi(x)$ a f :

$$(\ ) = \frac{\nabla\phi(x)}{\|\nabla\phi(x)\|} \quad (18)$$

L f H a d a d d fi c a (16). R f Figure 4, H a d fi c a a d ac (d c); c a , a d fi c ca a a d (a d c) ac face a a d d a f d ac . W d a , H a d a d d fi c a d d b (d):

$$H(\phi) = \begin{cases} 1 & \phi / 0 \\ 0 & \phi . 0 \end{cases} \quad \text{a d} \quad \chi_j(\ ) = |\phi(\ )| - |\phi(\ _j)| \quad (19)$$

T a d f a f a -c d d b b d ac a a $\tilde{\ }^e$ f (16) a f (14) a d (15). F , , a , a d a c a c a V a [27].



F... 4. A ... a f ... f (a) ...a ... d... a d (b) ... d ... fi c ... d... ... a d ...a d c ... , ... c ... .

Bulk energy

S a ... b ... , ... a ... a ... $\delta\tilde{W}_b^e$ f δW_b^e ... a d a d ... :

$$\delta\tilde{W}_b^e = \int_\Omega \delta\epsilon^e : {}^e : \epsilon^e \,d\Omega = \delta\, {}^{eT} \cdot \int_\Omega {}^{eT}\{{}^e\}\, {}^e \,d\Omega \cdot {}^e \tag{20}$$

... ^{e} a d $\{{}^e\}$ a ... b ... c ... a ... a ... f ... e ... a a d V ... a ... , ... c ... . I add ... , ... a d a d ... a ... f ... a ... fi c ...

External energy

F a , a a f a a c a d a da d a c , a d b :

$$\delta\tilde{W}^{e} = \delta \, {}^{eT} \cdot \int_{\Omega} {}^{eT} \, \mathrm{d}\Omega + \int_{\partial\Omega_F} {}^{eT} \, \mathrm{d}\Gamma \tag{30}$$

Final XFEM equation

U E a (20), (22), (28), a d (30), a d a f (14) a d (15), XFEM a f a a f :

$$({}^{e}_{b} + {}^{e}_{d} + {}^{e}_{s}) \cdot {}^{e} = {}^{e} - {}^{e}_{s} \tag{31}$$

da d ac e c d f c b f c , a d c , a d d c d :

$$^{e} = [\quad ^{-}\{ \nabla \quad \rangle \quad \in$$

d

$\mathrm{d}\Omega$

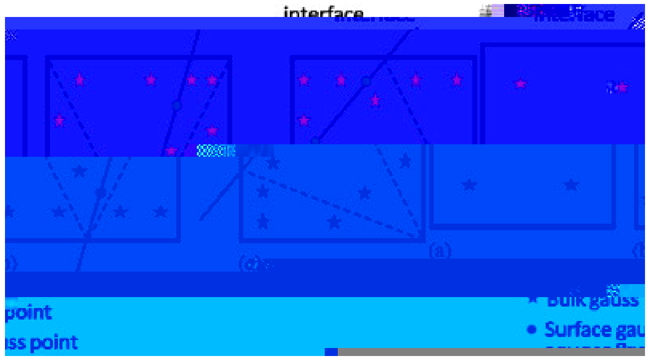
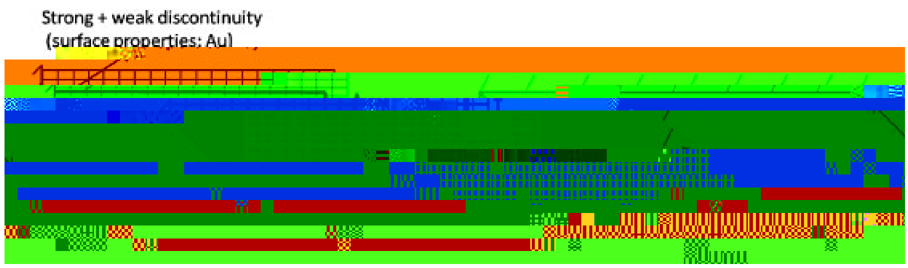


Figure 5. ... : (a) ... ; (b) and (c) ... .

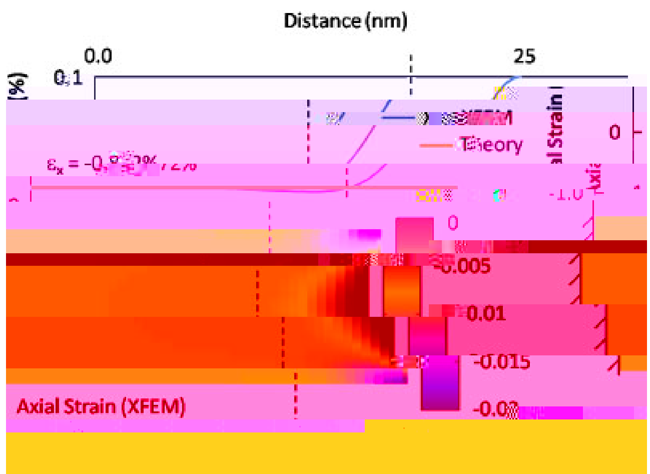
... [34] ... Figure 5 ... Ω_2 ...

NUMERICAL EXAMPLES

- ...
- ...
- ...



F[illegible] 6. Sc[illegible] XFEM [illegible].



F[illegible] 7. A c[illegible] E[illegible] (40) a d XFEM a[illegible].

[illegible] E[illegible] (40) a d [illegible] XFEM [illegible]. W[illegible] E[illegible] (40), [illegible] P[illegible] XFEM ca[illegible].

B ca ≫ t, ca c t + t (41) a d a :

$$\frac{F}{\quad} = \sigma t + 2\tau \tag{42}$$

If E a d S_{1111} a b Y ' d a d a a fac a c c a , c , ca a :

$$_1 = \frac{\sigma}{E} \quad \text{a d} \quad _2 = \frac{\tau}{S_{1111}} \tag{43}$$

$_1$ a d $_2$ a a a a b a d fac , c . C b E a (42) a d (43) a d a $_1 = {}_2 = \delta L / L$, b a :

$$\frac{E}{\delta L} = \frac{Et}{L} + \frac{2S_{1111}}{L} = K_b + K_s \tag{44}$$

K_b a d K_s a b a d fac a a ff , c . F (44), a f a a f d a Tab I a c d d, b ca b Y ' d E c a a S_{1111}, c a fac ff K_s b b f a a , b c c a a f a a a . F , E a (44) d a a a c a f a t / L a a ca ff c b , a d a ff f a a . F 9 c a a a ff a a fi c f a a , a a c a t / L a c a a 10. A ca b F 9, a c a f d b ca E a (44)

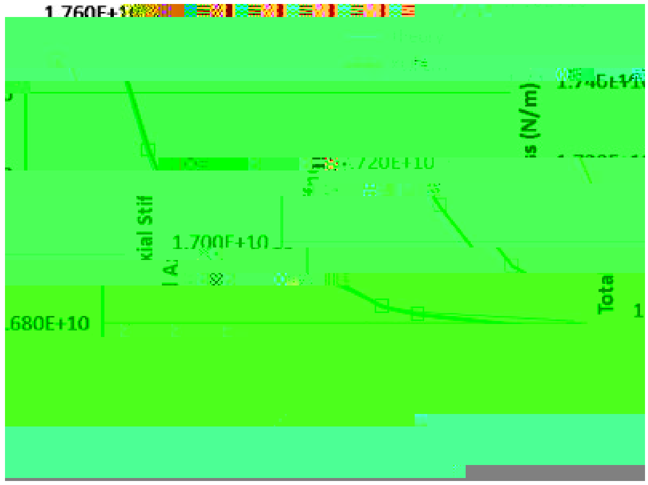


Figure 9. Surface effect [illegible] 10.

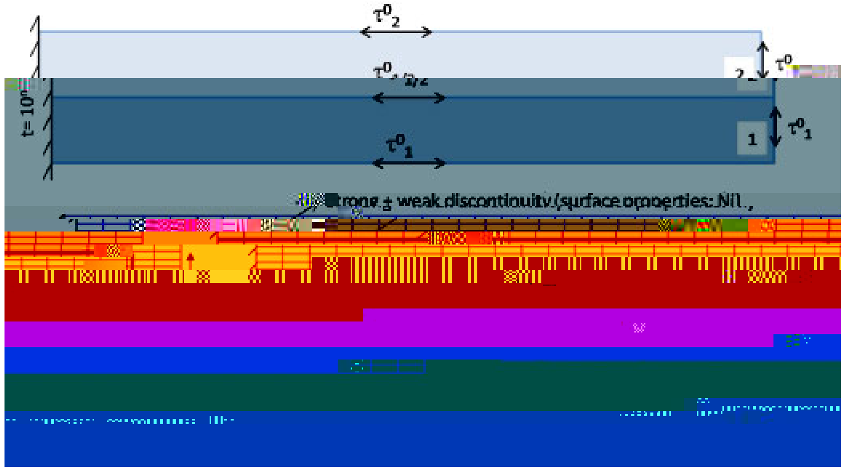


Figure 10. Ge[illegible] surface and [illegible] surface effect.

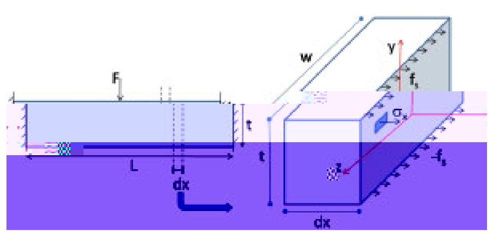
If [illegible] τ^0_1, τ^0_2, and τ^0_{12} a[illegible] surface [illegible] (f[illegible]) [illegible] 1, 2 and [illegible] surface [illegible] 1 and 2, [illegible] (M) [illegible] surface [illegible] 1 and 2 a[illegible]:

$$M=(\tau^0_1)(t-x)-(\tau^0_2)x+(\tau^0_{12})\left(\frac{t}{2}-x\right) \tag{47}$$

C[illegible] © 2010 J[illegible] W[illegible] & S[illegible], Ld.

DOI: 10.1002/[illegible]

F ig e 11. (a) A a a c a b XFEM a d (E a (49) (51)) d b ifac a d fac f a b - a d P N a a , (b) a d c c a a b - a d P N a a b XFEM a d (E a (52)) d b ifac a d fac .



F ig e 12. Sc a c f a d d a b a b b a a d f c F.

a ca c a XFEM . T b d b f c - c F ig e 12 ca b a

$$\int_A \sigma_x y \, dA + 2 \int f_s \frac{t}{2} \, dz = -M \qquad (53)$$

σ_x a a f c - c a d f_s f c d c d b a ifac d ifac a c c a S_{1111}; $f_s = S_{1111}$ a , a a a a a co a d b ifac . B a a da d a $\sigma_x = E$ a d

C © 2010 J W & S , L d.

=(y y a) a a d b (53) d a :

$$\frac{2E}{t} \;\mathrm{a} \int_A y^2\, \mathrm{d}A + S_{1111} t \;\mathrm{a} = -M \tag{54}$$

K a $I = \int y^2\, \mathrm{d}A$, I c f a a d a z, ca :

$$\mathrm{a} = \frac{-M}{\frac{2EI}{t} + S_{1111} t} \tag{55}$$

F c a a c F 12, $I = \frac{1}{12} t^3$; f , ca f E a- (55) :

$$\mathrm{a} = \frac{-M}{t(\frac{1}{6}Et + S_{1111})} \tag{56}$$

f ca :

$$= \frac{-2My}{t^2(\frac{1}{6}Et + S_{1111})} \tag{57}$$

If c d F a d d

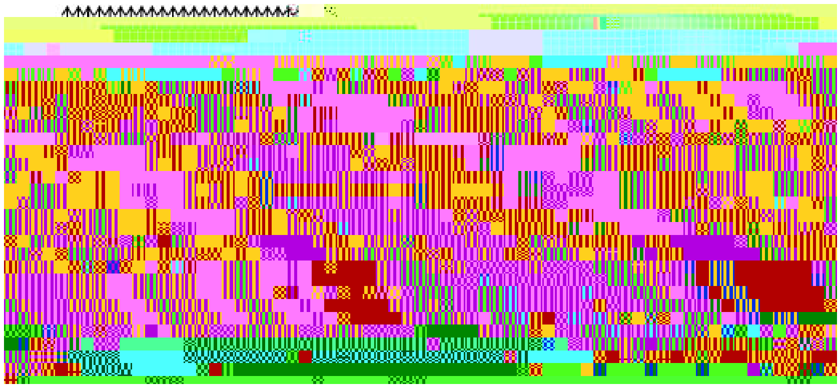
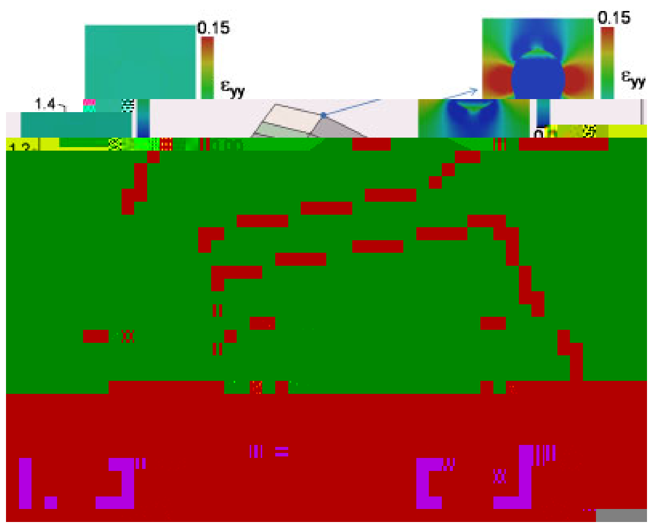


Figure 14. G[illegible] (a) [illegible] and (b) [illegible] ([illegible] surface [illegible]). Sub-[illegible] surface [illegible].



- T d ab d c b c a a b a a -c c a a c da a . I a f f d fac a d fac ffc d f a a d fac f a -c c .

T d d d a d a f ca a fac- -d a a f a a a d a - a a b-a a a , fac ffc a a ff f a a a , a d fac ffc b d ff f a a b a . I a ca , XFEM ca c a d d a a ca . F , a da ca f fac- -d a a f d a a a f d a b c a a c a d ca SCB ca a . F a , a a , a c b a f a a d d c a d ca ac b fac d c a d fac a c a a a c . T c f fac a d d c a ca a ca f c a c d b a d. S c fac a c a a c a d c , b d a d d c a a a c b c a d a a c d d. H , ffc b d fac c a d.

F f c a ffc f a c a d fac d c d f a [38 40], a a d a d a fac ffc ac c a ca f a a a .

ACKNOWLEDGEMENTS

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9.0754259999 0 .9968(d c H1) 68(d c H1) 0 Tc383.9(L)9.8 L 2(a 103.2 c)( )0(a 9.8) a ,P ca R c ; fB