## Crack Propagation Program with Material Memory Effect Simulation

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"GNU Free Documentation License". ( "http://www.gnu.org/licenses/fdl.html" ) From experiment on uni-axial sample:



Loop A - B will close at return to A

A - F is a return to the initial loading curve.

ole

First Reversal is stored in both Compressive and Tensile limit stacks "LIFO" Stacks

0.8%

<u>CLIM TLIM</u> -08 08 - -



(b)

The 2<sup>nd</sup> Rev. is a Compressive limit and is put in CLIM

"LIFO" = Last In First Out

(a)





4<sup>th</sup> Rev.is compressive and goes into⊂CLIM

(d)



Both limits are removed and the loop is "counted"

entry in Tlim for exceedence

The same counting method applies to any variable of a component: Nominal load/strain, local stress/strain, fatigue damage, etc.

### and also Stress Intensity





			STA	CKS			
	COMP	RESSION			TENS		
DAMAGE	STRESS	STRAIN	LOAD	LOAD	STRAIN	STRESS	DAMAGE
Doi	- ơ,	– e,	P,	P	ε	σ	D
D <sub>12</sub>	σ	€ <sub>2</sub>	Pz	-	-	-	-
-	-	-	-	-	-	-	-

4P

 $\circ$ 



# Stress Intensity K follows Br. Std. BS-7910





"t\_MmMb\_Surflaw\_90" u 3:4:6 +--+--+









da/dN, mm/cycle









#TYPE= plate surface flaw #with or without weld using ACTIVATEs: #ACTIVATE MmMb= 1 # Deactivate = 0#ACTIVATE MkmMkb= 1 #ACTIVATE fw= 1 # #Other #TYPE= options: # # plate long surface flaw # plate tru flaw # # plate embedded flaw # # # plate edge flaw # # # # pipe inside flaw # (All dimensions in mm) 25.4 #B= # plate (or pipe wall) thickness #W= 101.6 # plate width # Internal diameter if pipe problem. Ignored if not pipe #ri= 0. #azero= 0.5 # initial crack depth #czero= 4.0 # initial 1/2 crack width at surface #L= 66.8 # Weld Feature width. Ignored if ACTIVATE MkmMkb= 0 (above) #HISTORYFILE= cycleR=0.5 10 # historyFileName # # Note that the MEANADD (below) is added AFTER the MAGFACTOR is applied. # Multiply factor on membrane load. Result should be MPa #MAGFACTOR m= 1.0 # Multiply factor on bending load term. Result should be MPa #MAGFACTOR b= 1.0 # Mean shift in MPa added to membrane stress. #MEANADD m= 0.0 #MEANADD b= 0.0 # Mean shift in MPa added to bending stress. # Max no. history repeats in simulation. #MAXREPS= 1000000 # # #MATERIAL= merged a36 fitted.html #DADN= table # Can be "table" or "Paris" #DADN\_PARIS= 0.0 0.0 0.0 0.0 none # Kth a m Kc units (ignored if #DADN= table)
#DADN\_TABLE= a36\_Old+New\_comboDadn.tbl # digitized da/dN curve for material,



history

plateA36aug0.95 History of Factors for Depth a and Surface c

History of Kmax, Kmin for Crack in Direction a 350 1000 "plateA36aug0.95.dat" u 3:<u>6</u> 300 Kmax, or Kmin for each History Interval 800 250

700000 800000

900000



400

200

0

-200

-400

-600

0

200000

100000

300000

400000

500000

1/2 Cycles or Reversals

600000

Kmax,

1e+0

Using example variable amplitude history

300000

400000

500000 600000

1/2 Cycles or Reversals

200 150

100

50

0 -50

-100

-150 -200

0

100000 200000



History of Kmax, Kmin for Crack in Direction c

u 3:9

800000

700000

900000

1e+06

×



"Load" is stress intensity "Damage" is da or dc for each 1/2 cycle and

"Damage2" is a or c

STACKS

	COMPI	RESSION		TENSION						
DAMAGE	<u>STRES</u> S	STRAIN	LOAD	LOAD	STRAIN	STRESS	DAMAGE			
D <sub>o I</sub>	- o <sub>i</sub>	– e <sub>1</sub>	P <sub>1</sub>	P	ε	σ	D <sub>01</sub>			
D <sub>12</sub>	σ	€ <sub>2</sub>	P2	-	-	-	-			
5 <del></del>	-	-	-	-		-	—			
· · · ·		1_0		_		-	<del></del> .			

#### F.D.& E. saefcalc1 from UoWaterloo Calc. Site

Mon Dec 24 00:41:17 EST 2012

#NAME= ASTM-A36 #NAME= Structural #NAME= Steel #Sy= 38.4 0.2pc offset, 265 mpa #Su= 69. ksi from | #read\_a\_line: # #MagFactor 1.0 879 -429 1 621 -429 1 621 0 1 514 85.7 2 557 129 2

#xcalc2	Loop	Smax	Smin	N	Sigmax	Sigmin	Delta	Epsmax	Epsmin D	eltaEps	%Eps %	sSWaT %	sts %M	orr %0	Goodm
#xcalc2	1	879.0	-429.0	1.0	367.	-298.	665.	0.01034	00229	0.01263	67.7	67.4	67.7	71.4	71.0
#xcalc2	2	621.0	-429.0	1.0	316.	-298.	614.	0.00653	300229	0.00882	28.8	25.2	28.8	21.4	16.6
#xcalc2	3	621.0	0.0	1.0	316.	-173.	488.	0.00653	0.00265	0.00388	2.5	4.1	2.5	4.5	6.7
#xcalc2	4	514.0	85.7	2.0	291.	-100.	391.	0.00512	0.00282	0.00231	0.5	1.6	0.5	1.2	2.4
#xcalc2	5	557.0	129.0	2.0	301.	-90.	391.	0.00568	0.00337	0.00230	0.5	1.7	0.5	1.4	3.2
"···]D	C+				Channel	16- 0-				Jacob David	(5				
#xcalc3	Stra	inLite_к	eps Swai	_L1те_керs	Stressi	_тте_ке	os M	orrow_Re	eps Goo	aman_keps	; (Reps	s= кере	etions)		
#xcalc3		3818.0		3163.1	38	818.0		2522.4	ł	1810.8					

### Local Stress and Strain Response:



Using example variable amplitude history



### Test Sample Life and Initiation + Propagation Life, F.D.E. "T" Specimens

Simulation of Constant Amplitude F.D.E. "T"Tests

All Software GNU License Open Source

Available at: github.com

Crack Propagation (Linux compressed tar file of everything)

https://github.com/pdprop/pdprop/blob/Master/pdprop.tar.gz

pdrain.f Rainflow Cycle Counting program

https://github.com/pdprop/pdprop/blob/Master/Pdprop/CleanPdprop/pdrain.f

Initiation Life calculation program

https://github.com/pdprop/pdprop/blob/Master/Pdprop/CleanPdprop/saefcalc2.f