Results for rodA36_0.95 : Crack Propagation Rod Surface Flaw

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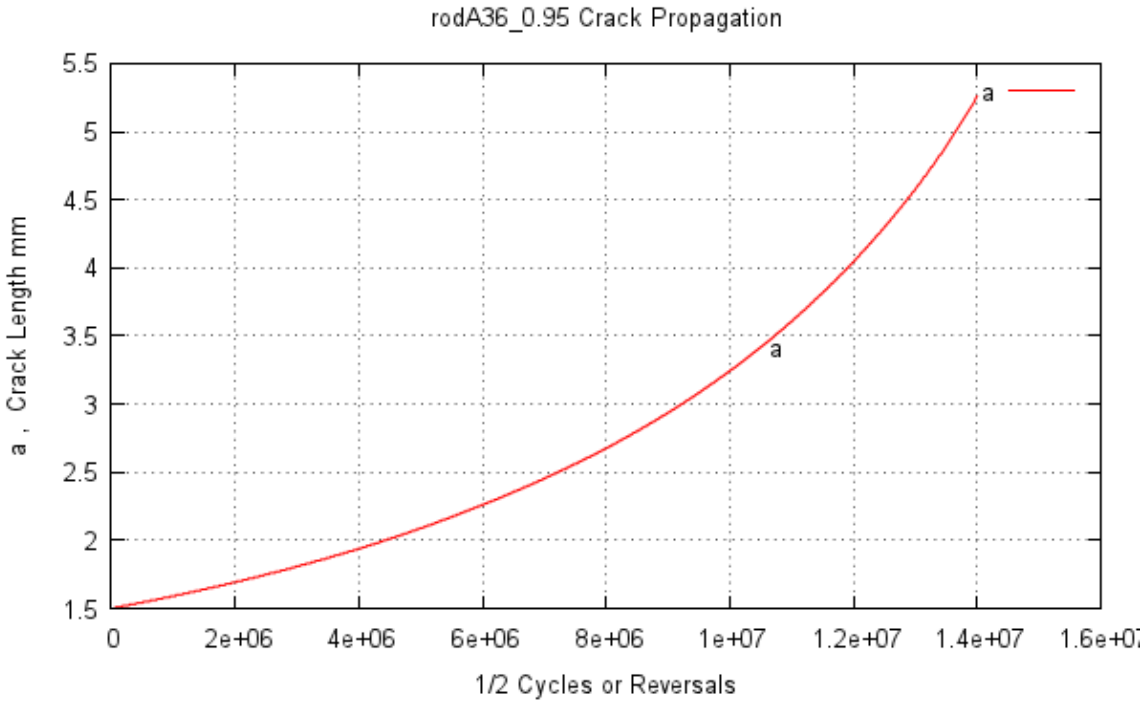
Simulation input data:
Radius= 13. mm
a_0= 1.5 mm
#MATERIAL= merged_a36_fitted.html
#TYPE= rod_surface_flaw
#ACTIVATE_MmMb= 1
M=Mkm=Mkb=fw=1.0

Crack Propagation Results:
(*# rodSurfFlaw.f vers. 3.06*)

- No. of Reversals= 14000001 revs. or 7e+06 cycles
- Final _____ **a** = 0.526E+01 mm
- No. of History Reps.= 1000001 reps. + 1 revs.



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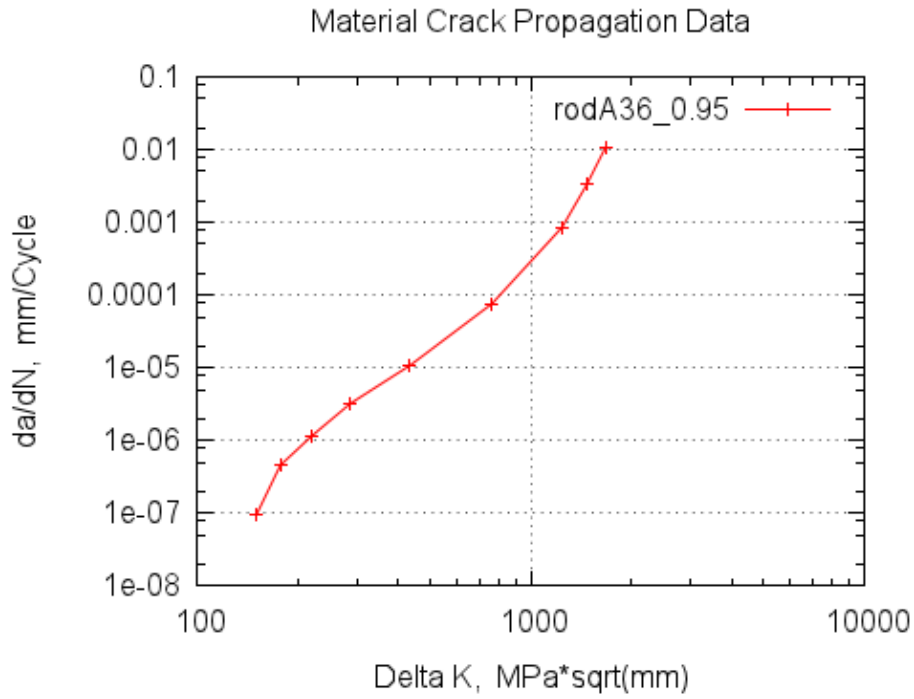
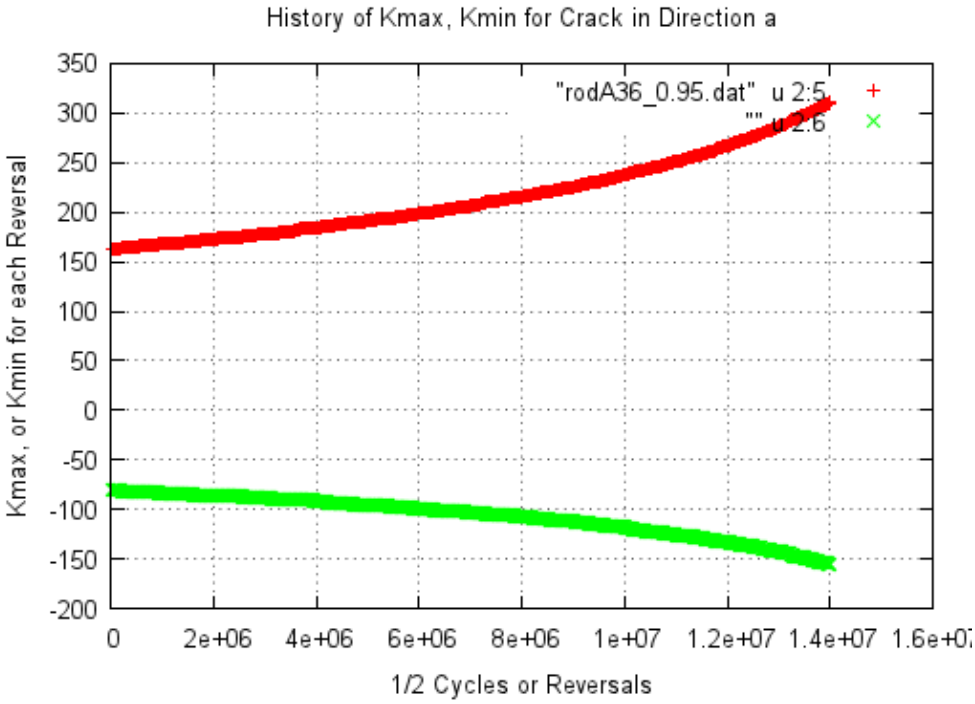
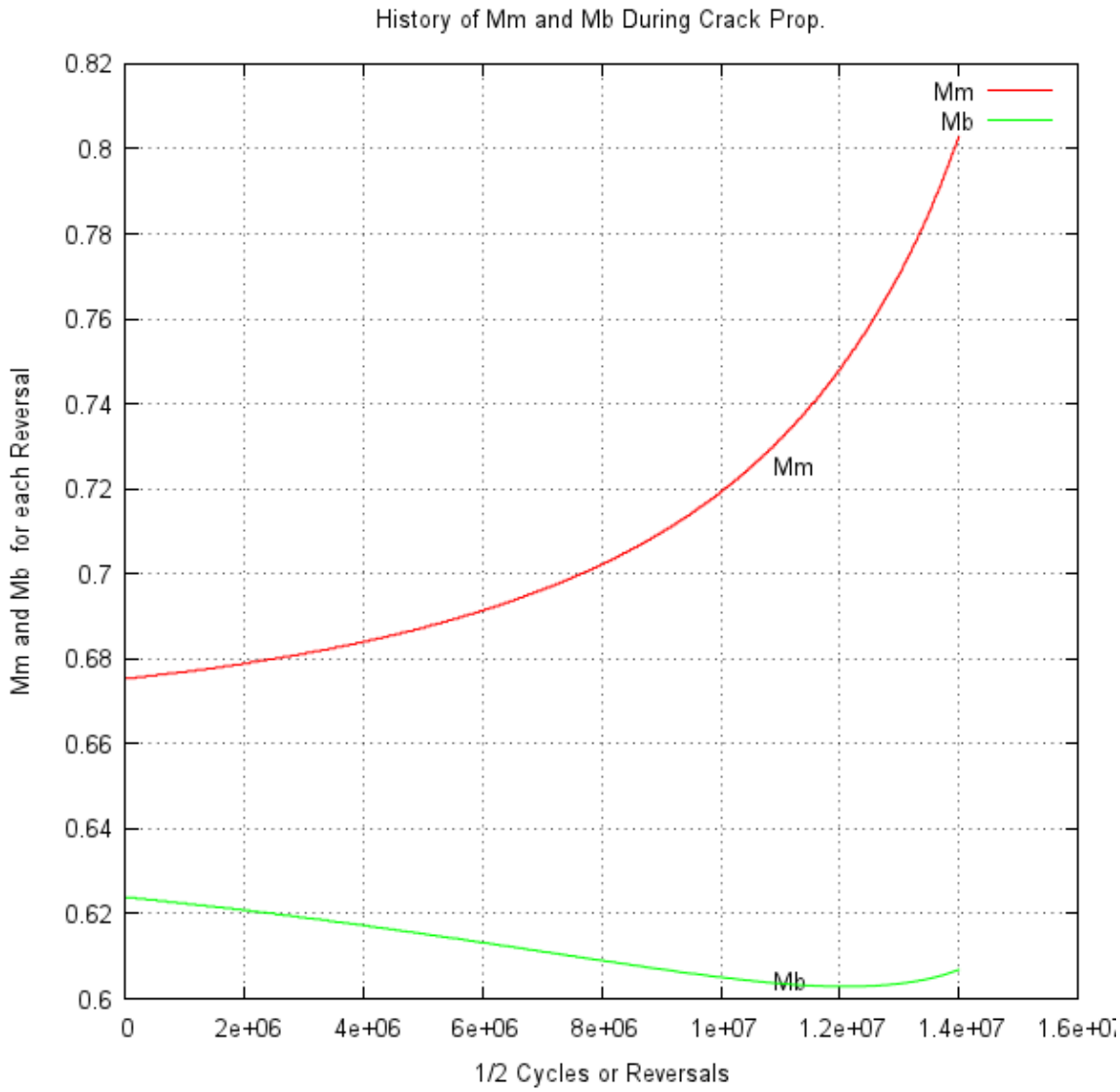
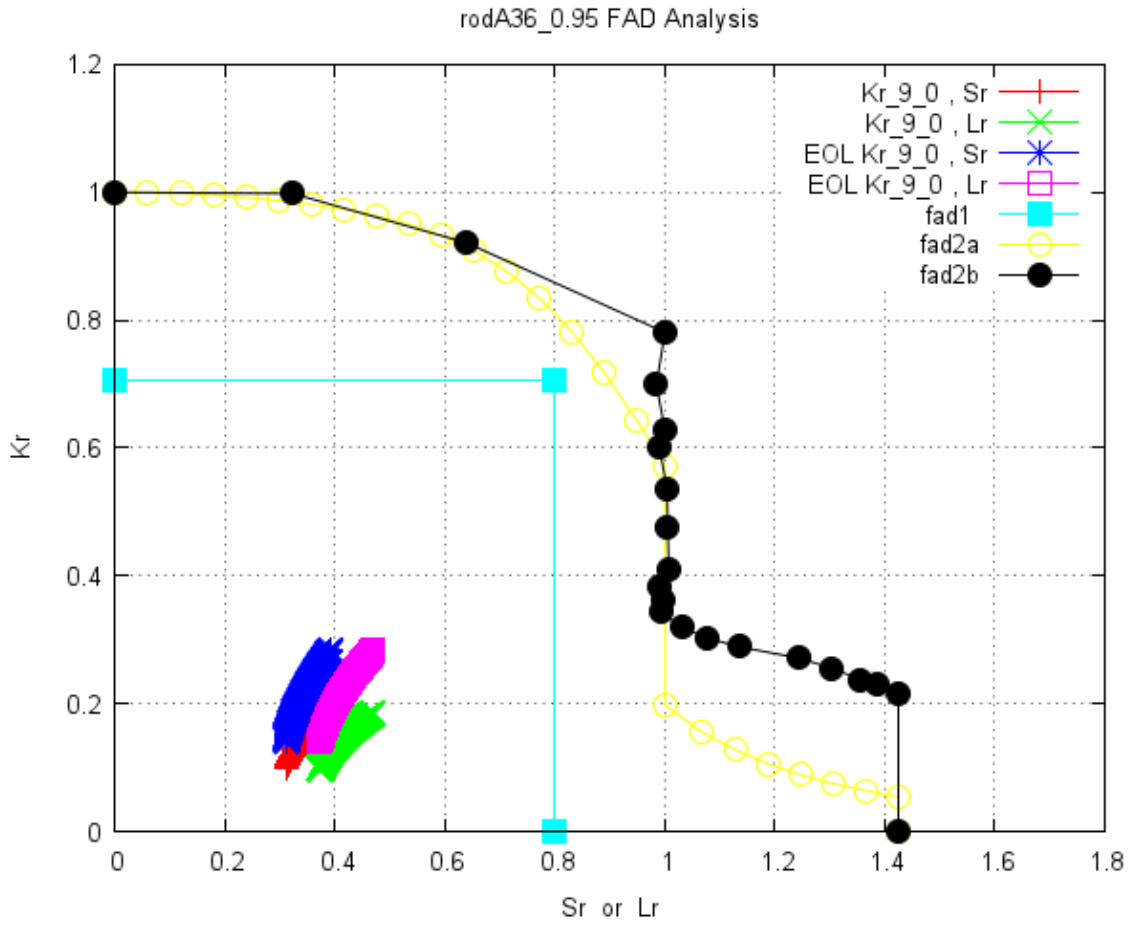



History of Kmax, Kmin for Crack in Direction a
"rodA36_0.95.dat" u 2:5
"" u 2:6
Kmax, or Kmin for each Reversal
1/2 Cycles or Reversals
350
300
250
200
150
100
50
0
-50
-100
-150
-200
0
2e+06
4e+06
6e+06
8e+06
1e+07
1.2e+07
1.4e+07
1.6e+07


History of Mm and Mb During Crack Prop.
Mm and Mb for each Reversal
1/2 Cycles or Reversals
Mm
Mb
Mm
Mb
0.82
0.8
0.78
0.76
0.74
0.72
0.7
0.68
0.66
0.64
0.62
0.6
0
2e+06
4e+06
6e+06
8e+06
1e+07
1.2e+07
1.4e+07
1.6e+07

FAD Results for rodA36_0.95
#TensileFile= a36_Mattos_mono_engrSS_FLAT.txt

#PmEOL= 70. #PbEOL= 100.
#Kmat= 1675.



Crack Initiation Life Results for rodA36_0.95 (Assume Kt= 1.8 for welds)

Files Used:

- Stress History (Sb+Sm)
- Rainflow File
- Material File

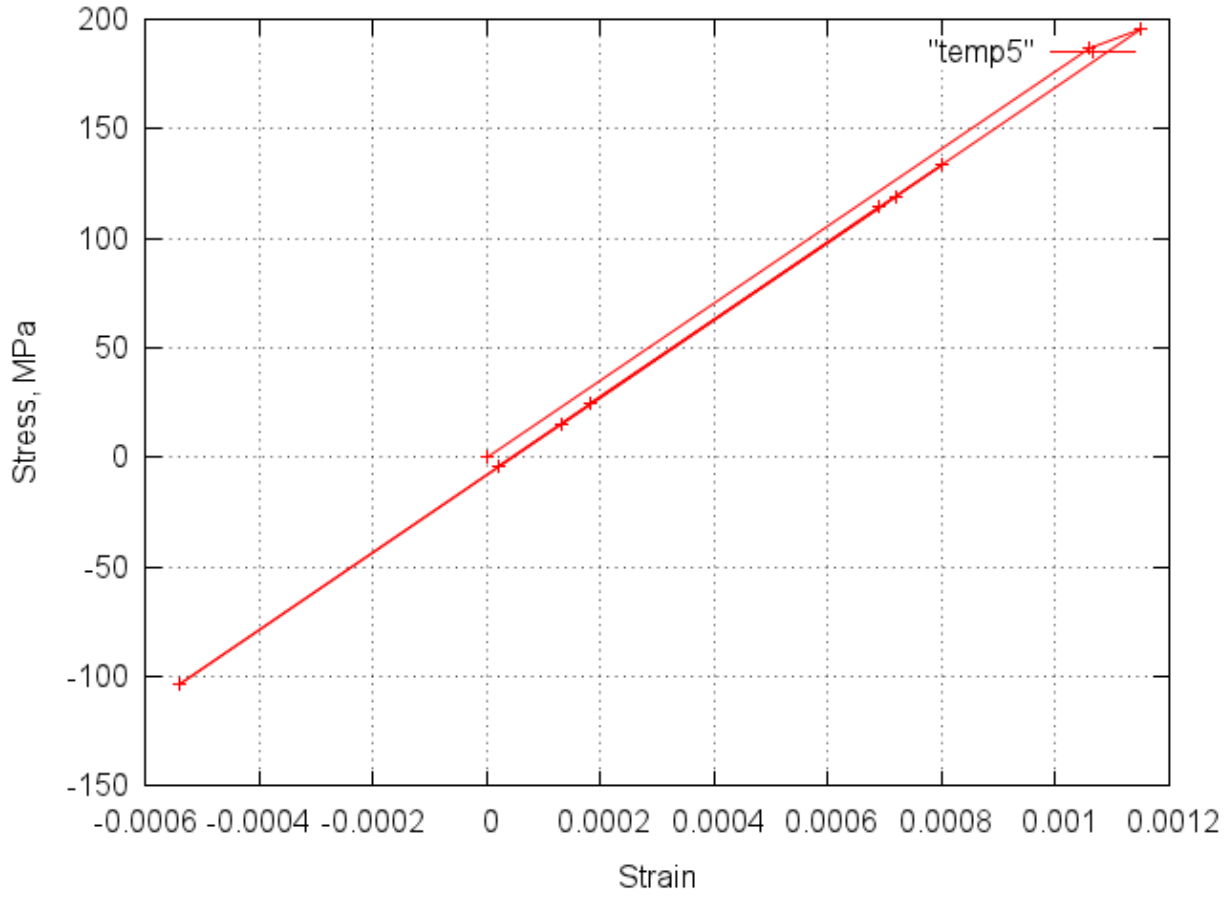
Loop	Smax	Smin	N	Sigmax	Sigmin	Delta	Epsmax	Epsmin	DeltaEps	%Eps	%SWaT	%Sts	%Morr
1	214.2	-106.9	1.0	195.	-103.	299.	0.00115	-.00054	0.00170	0.0	0.0	0.0	0.0
2	147.6	-106.9	1.0	133.	-103.	237.	0.00080	-.00054	0.00134	0.0	0.0	0.0	0.0
3	147.6	0.0	1.0	133.	-4.	137.	0.00080	0.00002	0.00078	0.0	0.0	0.0	0.0
4	127.3	20.3	2.0	115.	15.	99.	0.00069	0.00013	0.00056	0.0	0.0	0.0	0.0
5	132.3	30.6	2.0	119.	25.	95.	0.00072	0.00018	0.00054	0.0	0.0	0.0	0.0

Predicted History Repetitions to Initiation:

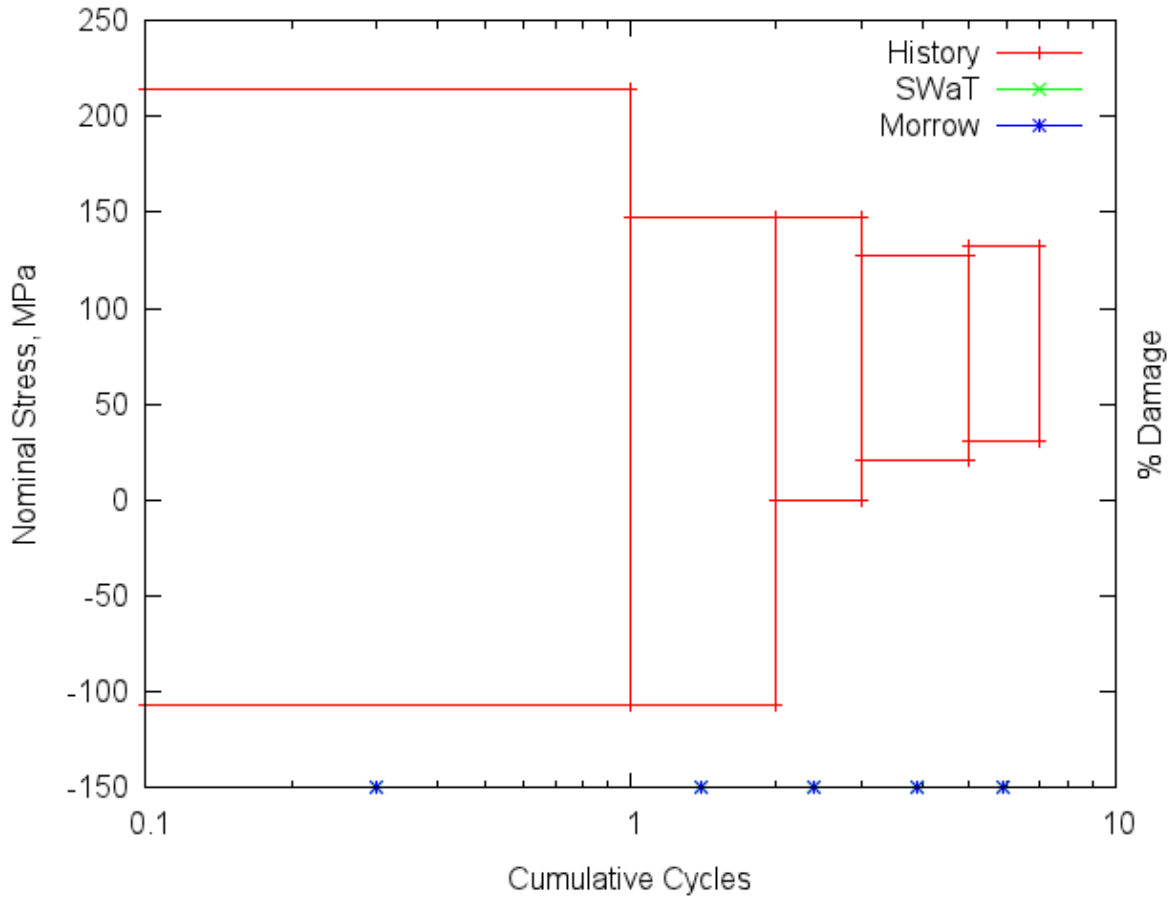
StrainLife_Reps	SWaT_Life_Reps	StressLife_Reps	Morrow_Reps	Goodman_Reps
Infinity	Infinity	Infinity	Infinity	Infinity

(Reps= Repetions)

Local Stress and Strain Response:



Cumulative Cycle Plot of History and Damage:



(Rectangles are Rainflow Cycle Sets: Sorted by Range: largest on Left)

Appendix 1: Print of "pdprop.env" Simulation Control file

```
# This file contains the starting filenames, variables etc
# for the Crack Propagation  programs.   It should be edited by the
# user for each simulation.
#
#TYPE= rod_surface_flaw     #with or without weld using ACTIVATEs:
#ACTIVATE_MmMb=    1   #  Deactivate  = 0
#ACTIVATE_MkmMkb=  0   #  Note used in rod_surface_flaw
#ACTIVATE_fw=      0   #  Note used in rod_surface_flaw
#                              #Other      #TYPE=  options:
#                              # plate_surface_flaw
#                              # plate_tru_flaw
#                              # plate_embedded_flaw
#                              # plate_long_surface_flaw
#                              # plate_edge_flaw
#                              # pipe_inside_flaw
#                              # pipe_full_inside_flaw
#                              # pipe_full_outside_flaw
#                              #
#                              # rod_surface_flaw
#                              # rod_full_outside_flaw

# The factors described in this section may be ignored if not applicable to
```

```
# the particular problem type described above.
# (All dimensions in mm)
#B=  0.0   # plate (or pipe wall) thickness
#W=  0.0   # plate width
#ri=  13.    # Internal diameter if pipe problem. Ignored if not pipe
#azero= 1.5  # initial crack depth
#czero= 0.0  # initial 1/2 crack width at surface. Not used in Rods Surf.
#L= 00.      # Weld Feature width.  Ignored  if ACTIVATE_MkmMkb= 0 (above)

#HISTORYFILE=  load1.txt    # historyFileName
#           # Adjustments to load file variables:
#           # Note that the MEANADD (below) is added AFTER the MAGFACTOR is applied.
#MAGFACTOR_m= 1.0     # Multiply factor on membrane load. Result should be MPa
#MAGFACTOR_b= 1.0     # Multiply factor on bending load term. Result should be MPa
#MEANADD_m=   0.0     # Mean shift in MPa added to membrane stress.
#MEANADD_b=   0.0     # Mean shift in MPa added to bending stress.

#MAXREPS=  1000000    # Max no. history repeats in simulation.
#                    # One repetition or application of the load history is
#                    # also called a "block" of cycles.
#
#
#MATERIAL=  merged_a36_fitted.html   #File name of material fitted data
#                                This file is used to define the cyclic
#                                stress-strain curve, and the Neuber Product curve.
#
#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+1015.dadn    # da/dN digitized da/dN curve for material,
#                                including the threshold, and KIc.
#                                If a threshold exists, put in a vertical line
#                                (with two identical X-axis points).
#                                If the threshold needs to be "turned off" then
#                                do NOT put in a vertical line at low da/dN.
#                                (Ignored when #DADN= PARIS )
#
#FAD Stuff:
#TensileFile=  a36_Mattos_mono_engrSS_FLAT.txt     #enter "none"  if no FAD
#PmEOL= 70.              #Set these so that Pm+Pb= 0.82*Syield for default.
#PbEOL= 100.
#Kmat= 1675.
#PinJoint= 0             # not used for rodSurfFlaw.f
#
#BLOCKSKIP=   1.0 percent       # At the end of each block check if the previous
#                                two blocks of cycles had similar damage (crack
#                                extension) within this percentage.  If TRUE then
#                                simply skip the simulation of the next block,
#                                but just add the expected damage.  Continue by
#                                simulating the block after the skip.
#                                A value of 0.0 will disallow skipping blocks.
#SAVELEVEL=  0               #Amount of output saved to disk:
#                            #   3=lots  2=medium  1=minimal
#                            #   0= save #crk=  data into binary direct access file only
#                            #      No #crk= data will be written into the text logfile.
#                            #      Use for large output files with lots of cycles.
```

Appendix 2: Print of da/dn vs DeltaK Table in file rodA36_0.95

```
   Delta_K        da/dN
```

```
0.1502160E+03  0.9620540E-07  0.2176716E+01 -0.7016800E+01  0.0000000E+00  0.0000000E+00     1
0.1769830E+03  0.4562300E-06  0.2247931E+01 -0.6340816E+01  0.7121539E-01  0.6759844E+00     2
0.2202350E+03  0.1160170E-05  0.2342886E+01 -0.5935478E+01  0.9495497E-01  0.4053378E+00     3
0.2874840E+03  0.3224090E-05  0.2458614E+01 -0.5491593E+01  0.1157272E+00  0.4438853E+00     4
0.4331670E+03  0.1069760E-04  0.2636655E+01 -0.4970714E+01  0.1780417E+00  0.5208793E+00     5
0.7637410E+03  0.7556810E-04  0.2882946E+01 -0.4121662E+01  0.2462907E+00  0.8490520E+00     6
0.1240590E+04  0.8520410E-03  0.3093628E+01 -0.3069540E+01  0.2106822E+00  0.1052122E+01     7
0.1471680E+04  0.3307300E-02  0.3167813E+01 -0.2480526E+01  0.7418513E-01  0.5890131E+00     8
0.1675690E+04  0.1074680E-01  0.3224194E+01 -0.1968721E+01  0.5638027E-01  0.5118057E+00     9
```

Appendix 3: Print of Stress-Strain-Init.Life file: "matfile"

```
#SAE Standard Fatigue Data File format
```

# #

Pick one: #FDE_plot #FDE_fit # #

```
#
#Copyright (C) 2012  F.D.E. Committee
#This data file is free software - you can redistribute it and/or
#modify it under the terms of the GNU General Public License as
#published by the Free Software Foundation; either version 2 of the
#license, or (at your option) any later version.
#This data file is distributed in the hope that it will be useful,
#but WITHOUT ANY WARRANTY - without even the implied warranty of
#MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
#GNU General PUblic License for more details.
#You should have received a copy of the GNU General PUblic License
#along with this program - if not, write to the Free Software
#Foundation, Inc., 59 Temple Place - Suite 330, Boston, MA 02111-1307, USA
#Try also their web site: http://www.gnu.org/copyleft/gpl.html
#
# NOTE:  Fitted Data !!
# A36 Steel Merged Data Sets from Refs. 1 and 2:
# Ref.1: P.Dindinger report to Fat.Des.+Eval. Comm. Apr.2012
# Ref.2: G.A.Miller and H.S.Reemsnyder, "Strain-Cycle Fatigue of Sheet and
# Plate Steels I:  Test Method Development and Data Presentation,"
# SAE Paper 830175, Detroit MI, Feb28-Mar.4, 1983
#
# NOTE that original test data ends at  2Nf = 1.3million.
#
#FileType= strain_life
#DataType= fitted
#TIMEcol= 0
#NAME=  ASTM-A36
#NAME=  Structural
#NAME=  Steel
#Stress_units= ksi
#Strain_units= strain
#Sy=    38.4 0.2pc offset, 265  mpa
#Su=  69.  ksi from Miller/Reemsnyder = 475 mpa
#eu=       0   #strain at Su not reported
#E= 29528. ksi  = 203600 mpa
#FractureStrain=  0 not reported
#FractureStress=  0. not reported
#monotonic_K= 0  not reported
#monotonic_n= 0  not reported
#BHN= 138.
```

```
#%RA= 0. %  not reported
#
#saedigcurve_v2.2.f starts.
# NOTE!! The Following Points are FITTED DATA:#NOTE!! Fitted Stress computed using Experm.
# Total Strain   2Nf  Stress  Mean   Plastic Strain   Initial
#    Amp               Amp   Stress      Amp        Elastic Mod.
   0.88485          1   115.3      0.   0.88095     29528. #Fitted_point
   0.00914       5000    52.1      0.   0.00737     29528. #Fitted_point
   0.00665      10000    48.8      0.   0.00499     29528. #Fitted_point
   0.00493      20000    45.7      0.   0.00338     29528. #Fitted_point
   0.00344      50000    42.0      0.   0.00202     29528. #Fitted_point
   0.00270     100000    39.3      0.   0.00136     29528. #Fitted_point
   0.00217     200000    36.8      0.   0.00092     29528. #Fitted_point
   0.00169     500000    33.8      0.   0.00055     29528. #Fitted_point
   0.00144    1000000    31.6      0.   0.00037     29528. #Fitted_point
#Original test data ends at  2Nf = 1.3million.
#Points below are extrapolation:
   0.00125    2000000    29.6      0.   0.00025     29528. #Fitted_point
   0.00106    5000000    27.1      0.   0.00014     29528. #Fitted_point
#
#
```