Using Crack Propagation Software

There are various commercially available programs, and probably a large number of individual programs, in existence for simulating crack propagation in engineering components. In this example we will be using an Open Source version which follows the recommendations of British Standard BS7910 closely.

A feature that has been added is the LIFO or Push-Down list material memory accounting system described in Chapter 5 of this tutorial. The Open Source type license that comes with the programs allows you to make software alterations to include any other features that you may wish to add. As usual there is of course **no warranty of any kind**. Please read the license at the top of the program listings and follow the web links to the full license terms.

The steps involved in computing damage or the propagation of a fatigue crack have been outlined in Chapter 8 of this tutorial. The present chapter section will demonstrate the use of the software to make predictions by means of an example.

The example simulates the tests and results by Kasra Ghahremani, "Predicting the Effectiveness of Post-Weld Treatments Applied under Load,", Link: MSc. Thesis Civil Engr., U.Waterloo, Canada, 2010.

F.A.Conle
Adjunct Prof
U.Waterloo, 2017

Details of the specimens and tests are available in the thesis and also at
https://fde.uwaterloo.ca/Fde/CaseStudies/GhahremaniMSc/ghahremaniCase4.html

Material:

CSA-350W (W=weldable) similar to ASTM-A572.:

G40.21-350W Simulated HAZ Constant Ampl. crack initiation Raw data

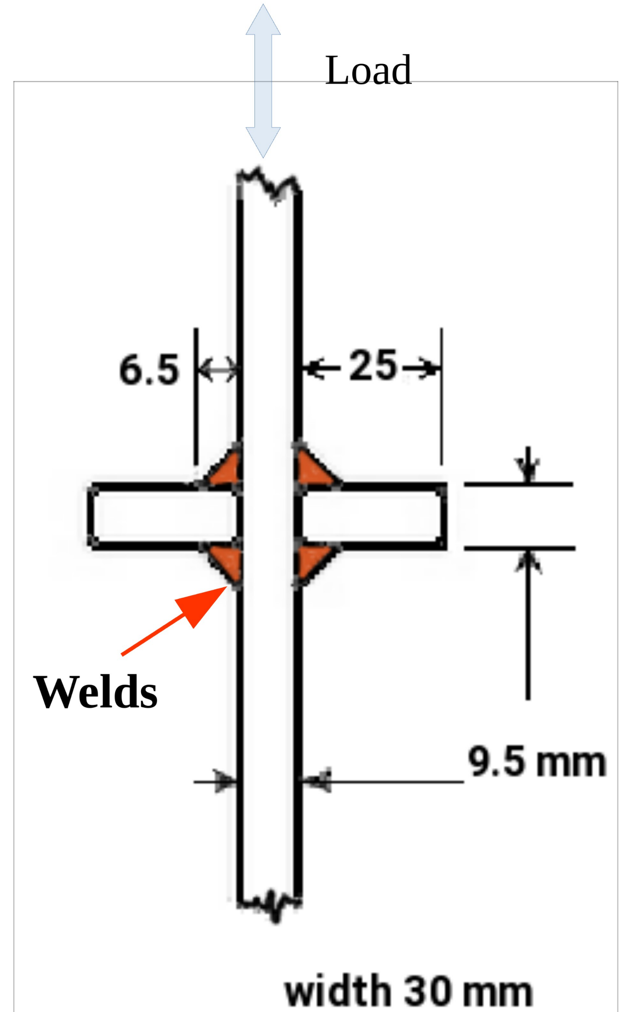
G40.21-350W Simulated HAZ Constant Ampl. crack initiation Fitted data

G40.21-350W Simulated HAZ Periodic Overstrain crack init. Raw data

G40.21-350W Simulated HAZ Periodic Overstrain crack init. Fitted data

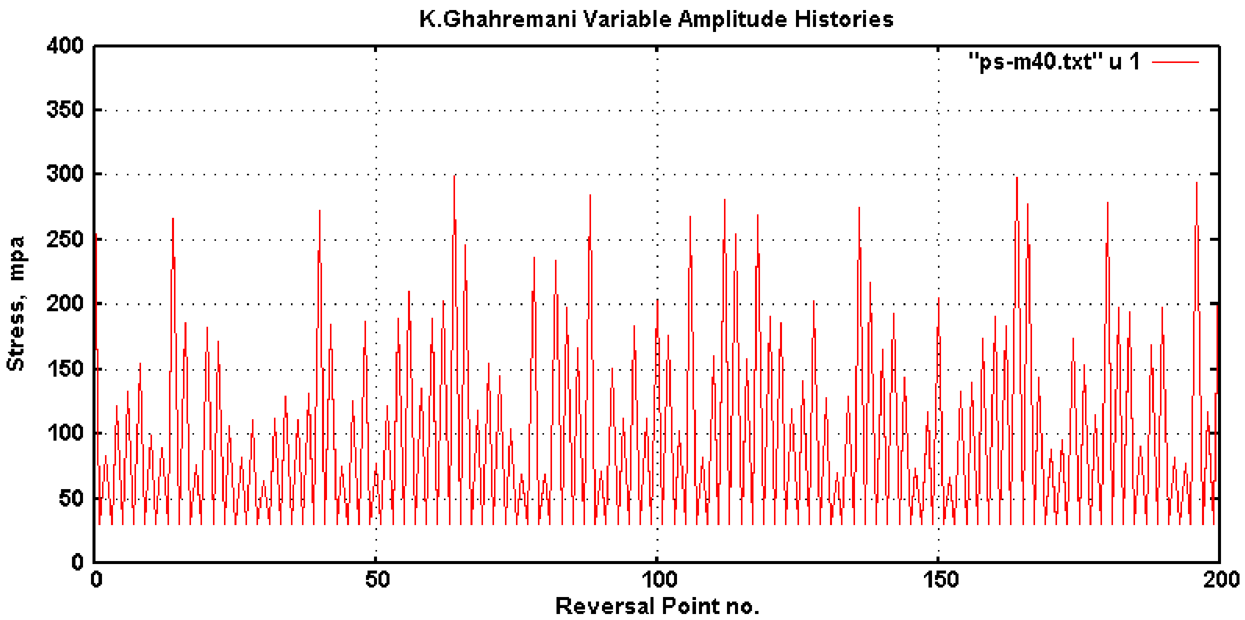
Crack Propagation da/dN data comparison plot

Crack Propagation da/dN Fitted data



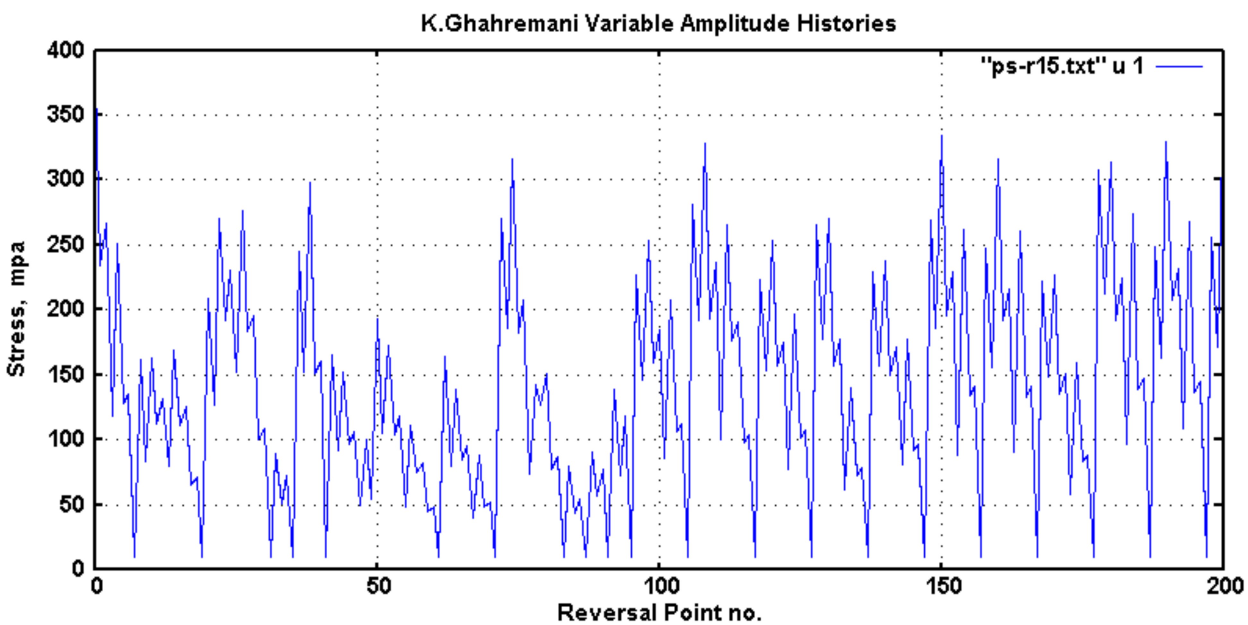
Geometry:
The specimens are 30mm wide plates with full width lateral stiffeners welded to each side as shown in the figure. Specimens were cut in parallel from wider welded plates and then machined to 30mm widths. For good welds the expected stress concentration factor at the toe of weld is 1.8 to 2.0

Loads:
The variable amplitude loading histories were observed on bridge members with loads generated by vehicles.



Links to load files for download:

ps-m40.txt



ps-r15.txt

Note that the load or stress histories have all reversal points above zero.

Setup Software

1. Download the *.tar file of the crack propagation programs:

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

    Copy or save this compressed tar file to a folder in which you will be doing your calculations. Use the command

    ```
    tar   xvf     pdprop.tar.gz
    ```

    to unpack the compressed file. A sub-folder CleanPdprop will appear.
    Assuming you have installed the compilers gcc and gfortran, go into this sub-folder

    ```
    cd  CleanPdprop
    ```

    and compile all the programs with the command:

    ```
    source  Allcompile
    ```

    or

    ```
    chmod  744    Allcompile
    ./Allcompile
    ```

1b. The folder CleanPdprop now consists of all the programs for crack propagation and also crack initiation; the latter using rainflow cycle counts as input.
If you expect to be simulating several different problems it may save some time to leave the contents of CleanPdprop as-is and make a copy to some other folder e.g.:

```
cp  -r  CleanPdprop  ~/Problem1/
```

This is a bit wasteful of disk memory, but it makes life easier when one has to return to a problem or simulation, after a period of time, to make changes.

1c. In order to make the pdf reports of simulation results you will also need to have available the programs: gnuplot and htmldoc
These are used by the makereport* scripts.

Files in CleanPdprop after Allcompile script is run

```
TempExample/CleanPdprop> ls -1
0_README
Allcompile
convert2MPa_mm
convert2MPa_mm.f
convertParis2table
convertParis2table.f
decimate
decimate.f
deletelarg
deletelarg.f
getFADs
getFADs.f
hilo2
hilo2.f
makeRepSaefcalc2
pdrain
pdrain.f
PipeInSurfFlaw
PlateEdgeFlaw
PlateLongSurfFlaw
PlateSurfFlaw
PlateThruFlaw
replaceline
replaceline.f
RodSurfFlaw
saefcalc2
saefcalc2.f
```

Programs to convert various da/dN formats into digital da/dN table with ΔK units of mpa*mm$^{1/2}$

Runtime folders that contain programs to simulate various flaw geometry types (as per BS7910)
Note that one must be in one of these folders to simulate crack propagation.

Crack initiation simulation program that uses Rainflow file inputs

The non-highlighted files are programs that are also common to and used by the simulation programs in the blue highlighted folders.

Going into the Problem1/CleanPdprop/PlateSurfFlaw one sees the following files:

```
CleanPdprop/PlateSurfFlaw> ls
a36+1015.dadn                      makereport1                   plateWeldflaw
a36+1015.dadn.user                 makereport1.bak               plateWeldflaw.f
a36_Mattos_mono_engrSS_FLAT.txt    matfile                       plateWeldflaw_range.f
dadnTable                          merged_a36_fitted.html        plateWeldflaw+ss.f
examplOut.pdf                      merged_a36_fitted.html.user   plotFADs
fads.table                         mkfile00                      setup1
g40.21-50A.dadn                    mkfile00_LoB=1.00             setup1.bak
g40.21-50A_non_os.fc.html          mkfile90                      SurfFlaw
g40.21-50A_non_os_fitted.html      mkfile90_LoB=1.00             temp.loads
g40.21-50A.paris                   pdprop.env                    t_MmMb_Surflaw_00
load1.txt                          pdprop.env.bak                t_MmMb_Surflaw_90
loadgp4                            pdprop.env.pwf                WeldSurfFlaw
loads4rain.out                     plateWeldFAD
makeInitReport                     plateWeldFAD.f
```

There are actually sufficient files, including example material files etc., to run the programs without adding any new user files, but we will go through the functions of the example files first before running the problems described in the previous pages of this chapter.

Scripts:

setup1 is a script which checks the user files to see if all is present for a simulation.
setup1.bak is a backup copy of setup1 available in case someone clobbers setup1

makereport1 is a script which runs the simulation and presents the results in a *.html report (also a *.pdf when htmldoc is available) makereport1.bak is a backup.
It is a good idea to read over this script to understand what it is doing.

makeInitReport is a script to run only the crack initiation simulation. The script uses some of the programs located in the folder ../CleanPdprop (above present folder)

```
TempExample/CleanPdprop> cd PlateSurfFlaw
CleanPdprop/PlateSurfFlaw> ls -1
a36+1015.dadn
a36+1015.dadn.user
a36_Mattos_mono_engrSS_FLAT.txt
dadnTable
examplOut.pdf
fads.table
g40.21-50A.dadn
g40.21-50A_non_os.fc.html
g40.21-50A_non_os_fitted.html
g40.21-50A.paris
load1.txt
loadgp4
loads4rain.out
makeInitReport
makereport1
makereport1.bak
matfile
merged_a36_fitted.html
merged_a36_fitted.html.user
mkfile00
mkfile00_LoB=1.00
mkfile90
mkfile90_LoB=1.00
pdprop.env
pdprop.env.bak
pdprop.env.pwf
plateWeldFAD
plateWeldFAD.f
plateWeldflaw
plateWeldflaw.f
plateWeldflaw_range.f
plateWeldflaw+ss.f
plotFADs
setup1
setup1.bak
SurfFlaw
temp.loads
t_MmMb_Surflaw_00
t_MmMb_Surflaw_90
WeldSurfFlaw
```

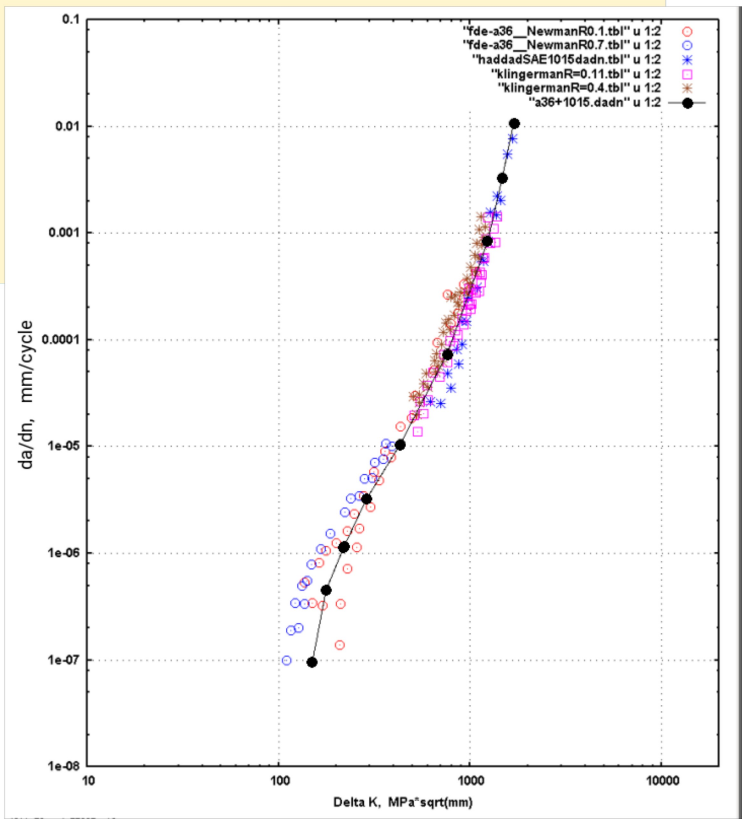
Digital da/dN curves e.g.:

cat a36+1015.dadn

```
#NAME= A36merged  data from Newman, Haddad, Klingerman
#Data digitized from merged graph in file a36+1015dadn-2.png
#
#deltaKunits= mpa_mm
#dadnunits= mm
#
# deltaK    dadn
#MPa*Sqrt(mm)  dadn mm/cycle
150.216  9.62054e-08
176.983  4.5623e-07
220.235  1.16017e-06
287.484  3.22409e-06
433.167  1.06976e-05
#622.194  3.55031e-05
763.741  7.55681e-05
#950.39  0.000224548
1240.59  0.000852041
1471.68  0.0033073
1675.69  0.0107468
```

Units of data in file

"#" character begins a comment line. (i.e.: not data)



Tensile test Engr. Stress-Strain curve
used to create FAD diagrams. (See BS7910)

```
TempExample/CleanPdprop> cd PlateSurfFlaw
CleanPdprop/PlateSurfFlaw> ls -1
a36+1015.dadn
a36+1015.dadn.user
a36_Mattos_mono_engrSS_FLAT.txt
dadnTable
examplOut.pdf
fads.table
g40.21-50A.dadn
g40.21-50A_non_os.fc.html
g40.21-50A_non_os_fitted.html
g40.21-50A.paris
load1.txt
loadgp4
loads4rain.out
makeInitReport
makereport1
makereport1.bak
matfile
merged_a36_fitted.html
merged_a36_fitted.html.user
mkfile00
mkfile00_LoB=1.00
mkfile90
mkfile90_LoB=1.00
pdprop.env
pdprop.env.bak
pdprop.env.pwf
plateWeldFAD
plateWeldFAD.f
plateWeldflaw
plateWeldflaw.f
plateWeldflaw_range.f
plateWeldflaw+ss.f
plotFADs
setup1
setup1.bak
SurfFlaw
temp.loads
t_MmMb_Surflaw_00
t_MmMb_Surflaw_90
WeldSurfFlaw
```

```
# A36 Steel Hot Rolled
# Machined from 5/8 inch hot rolled plate.
# Ref.: R.J.Mattos, F.V.Lawrence, "Estimation of the Fatigue Crack Initiation
#   Life in Welds Using Low Cycle Fatigue Concepts," Fracture Control Rep.19
#   Univ. of Illinois, Oct. 1975.

# NOTE!: For  BS7910 FADs required Tags are:
#     #FileType=   #DataType=   #Sy=   #Su=   #E=
#     #Stress_units=     #Strain_units=
#
#FileType= strain_stress
#DataType= engineering     #Can be "engineering" or "true"
#NAME= ASTM-A36
#NAME= HotRolled
#NAME= Steel
#Stress_units= mpa
#Strain_units= strain
#Sy= 224. mpa = 32.5 ksi
#Su= 414. mpa = 60.0 ksi
#eu= 0.14  #strain at Su
#E= 190000 mpa  27500 ksi
#FractureStrain=  1.19
#FractureStress=  952 mpa = 138 ksi
#monotonic_K= 780 mpa, 113 ksi
#monotonic_n= 0.258
#BHN= 0. not reported
#%RA= 69.7 %


#From initial MattosStress-Strain plot
0  0
0.00036   72
0.00073  143
0.00146  224
0.00206  220
0.00274  224
...etc.
```

```
TempExample/CleanPdprop> cd PlateSurfFlaw
CleanPdprop/PlateSurfFlaw> ls -1
a36+1015.dadn
a36+1015.dadn.user
a36_Mattos_mono_engrSS_FLAT.txt
dadnTable
examplOut.pdf
fads.table
g40.21-50A.dadn
g40.21-50A_non_os.fc.html
g40.21-50A_non_os_fitted.html
g40.21-50A.paris
load1.txt
loadgp4
loads4rain.out
makeInitReport
makereport1
makereport1.bak
matfile
merged_a36_fitted.html
merged_a36_fitted.html.user
mkfile00
mkfile00_LoB=1.00
mkfile90
mkfile90_LoB=1.00
pdprop.env
pdprop.env.bak
pdprop.env.pwf
plateWeldFAD
plateWeldFAD.f
plateWeldflaw
plateWeldflaw.f
plateWeldflaw_range.f
plateWeldflaw+ss.f
plotFADs
setup1
setup1.bak
SurfFlaw
temp.loads
t_MmMb_Surflaw_00
t_MmMb_Surflaw_90
WeldSurfFlaw
```

Crack initiation axial fatigue tests data Fitted Curve files.
used for crack initiation simulations. e.g.:

```
 # 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.
# NOTE!! The Following Points are <b>FITTED DATA:</b>
#NOTE!! Fitted Stress computed using Experm. K' and n'
# 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
etc. . . . .
```

Load or stress history example: load1.txt

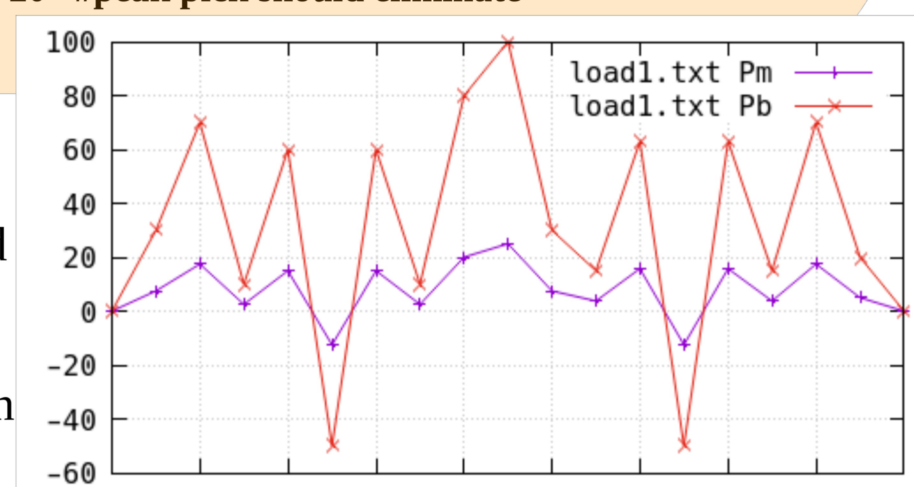
```
TempExample/CleanPdprop> cd PlateSurfFlaw
CleanPdprop/PlateSurfFlaw> ls -1
a36+1015.dadn
a36+1015.dadn.user
a36_Mattos_mono_engrSS_FLAT.txt
dadnTable
examplOut.pdf
fads.table
g40.21-50A.dadn
g40.21-50A_non_os.fc.html
g40.21-50A_non_os_fitted.html
g40.21-50A.paris
load1.txt
loadgp4
loads4rain.out
makeInitReport
makereport1
makereport1.bak
matfile
merged_a36_fitted.html
merged_a36_fitted.html.user
mkfile00
mkfile00_LoB=1.00
mkfile90
mkfile90_LoB=1.00
pdprop.env
pdprop.env.bak
pdprop.env.pwf
plateWeldFAD
plateWeldFAD.f
plateWeldflaw
plateWeldflaw.f
plateWeldflaw_range.f
plateWeldflaw+ss.f
plotFADs
setup1
setup1.bak
SurfFlaw
temp.loads
t_MmMb_Surflaw_00
t_MmMb_Surflaw_90
WeldSurfFlaw
```

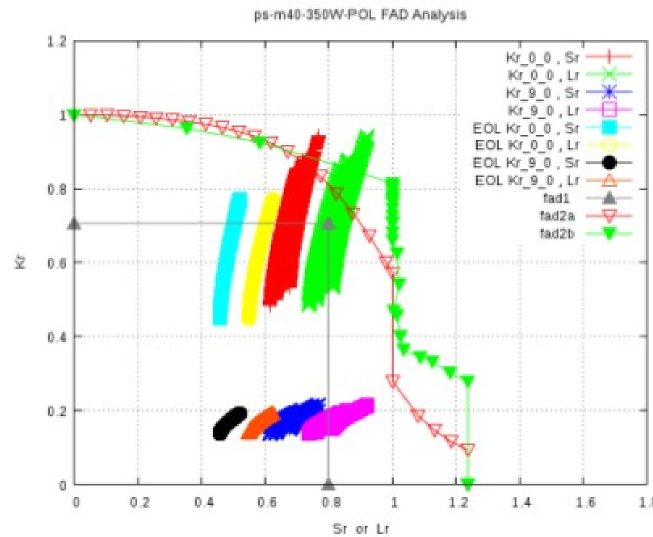
```
# Test load history no. 1
# This history purposely has several material memory
# events which would mess up a simple range count method.
#
#time Pm   Pb
1      0  0
2.    7.5 30.  #This point should be eliminated in peak pick
3   17.5   70
4   2.5   10
5   15.   60
6  -12.5   -50
7   15   60
8   2.5   10
9   20.   80.     #peak pick should eliminate
10  25.   100.
11   7.5    30     #peak pick should eliminate
12   3.75    15.
13. 15.75    63.
14. -12.5    -50
15   15.75    63
16    3.75    15
17   17.5    70
18    5.0    20   #peak pick should eliminate
19   0    0
```

In the histories there are three columns of data:

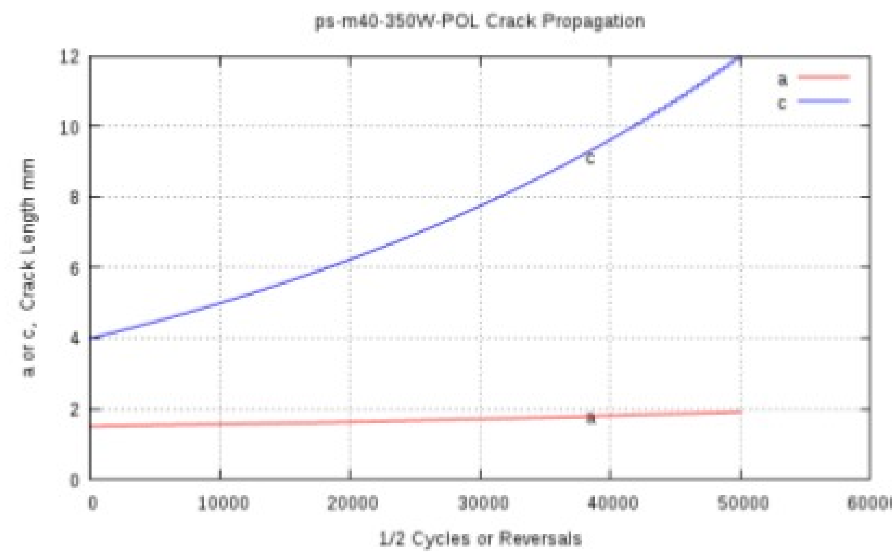
- time
- Pm Membrane stress or load
- Pb Bending stress or load

Pm and Pb are scaled up or down in control file pdprop.env





Executable program and source to compute
BS 7910 "**FAD**" **diagrams**
(FAD = Failure Analysis Diagram)



Executable program and source to compute **crack propagation**

Data folders of crack and plate geometry effects for ΔK computations

Run-time Control File: pdprop.env

cat pdprop.env

```
# This file contains the starting filenames, variables etc
# for the Crack Propagation  programs.   It should be edited by the
# user before each simulation run.
#TYPE= plate_surface_flaw     #with or without weld using ACTIVATEs:
#ACTIVATE_MmMb=    1       #  Deactivate  = 0
#ACTIVATE_MkmMkb=  1      #  Deactivate  = 0 (0 implies NO weld )
#ACTIVATE_fw=      1
#                      #Other     #TYPE=  options:
#                      # plate_long_surface_flaw
#                      # plate_tru_flaw
#                      # plate_embedded_flaw
#                      # plate_edge_flaw
#                      # pipe_inside_flaw
#                      # pipe_full_inside_flaw
#                      # pipe_full_outside_flaw
#                      # rod_surface_flaw
#                      # rod_full_outside_flaw
#                      # These problem types are used to pull in the
#                      # appropriate Fw, Mm, Mb, files etc.

# The factors described in this section may be ignored if not applicable to
# the particular problem type described above.

# (All dimensions in mm)
#B= 10.0   # plate (or pipe wall) thickness
#W= 70.0   # plate width
#ri= 200.   # Internal diameter if pipe problem. Ignored if not pipe
#azero= 1.5  # initial crack depth
#czero= 4.0  # initial 1/2 crack width at surface
#L= 10.      # Weld Feature width.  Ignored  if ACTIVATE_MkmMkb= 0 (above)
```

continued on next page

```
#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.
#Kt= 2.0              #Stress Conc. Factor, presently only for crack initiation calcs.
#
#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 )
```

continued on next page

```
#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.           #       "EOL"  stands for "End of Life"
#Kmat= 1675.
#PinJoint= 0           #Set = 1 if structure is pin-Jointed (for bending)
#
#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.
#                       (this feature is not ready yet.  0.0 is assumed )

#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.
```

(End of pdprop.env control file)

Note that there are a number of other files in the folder PlateSurfaceFlaw but they are not relevant for this example.

Lets run an example

Background information: K.Ghahremani MSc. Thesis Civil Engr., U.Waterloo, Canada, 2010.

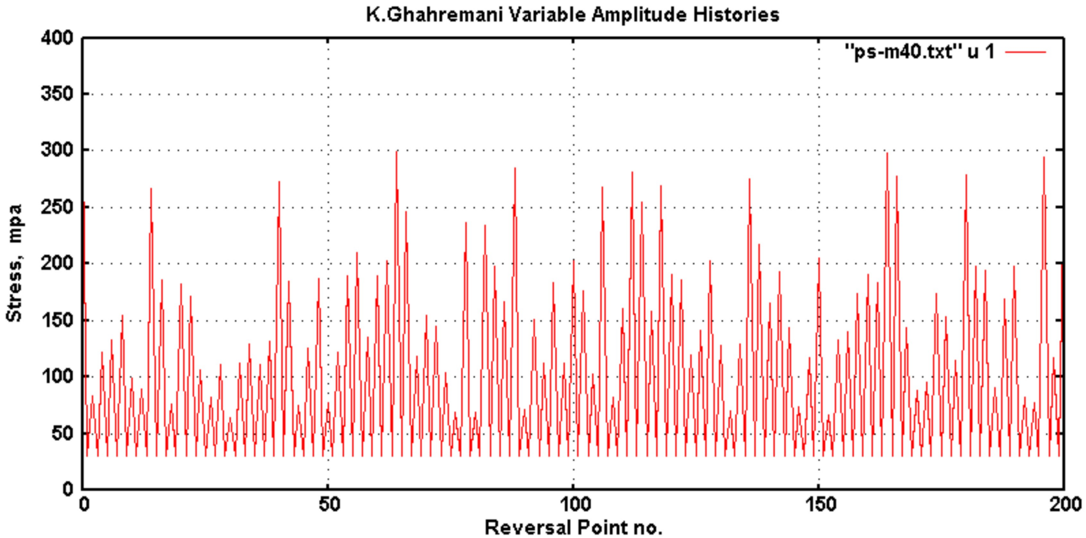
Step 1: As described in the previous pages of this chapter, we have downloaded a copy of the crack propagation programs, compiled them, and are now in a folder such as

…./CleanPdprop/PlateSurfFlaw

Step 2a: If you have not already done so, download Ghahremani's load file ps-m40.txt
Use vi or gvim to take a look at the contents. Generally it is a good idea to check at least the top and bottom of such a file.
The format for each data line in the file is

Point-No. Pm Pb No.Reps.

Only Pm (Membrane stress) and Pb (Bending stress) are used by the program at this time. Note that, in this case, all the Pb values are 0 i.e.: no bending
You can also use gnuplot to check if the values are similar to the plot below.



Or try:
hilo2 <ps-m40.txt
to check max and mins.

Step 2b. Enter the name of the file
ps-m40.txt
into the pdprop.env
control file

Step 2c. Use the magnification and mean shift factors to scale the Pm and Pb values. In this case the values in ps-m40.txt do not need any scaling or shifting.

```
...
...
# (All dimensions in mm)
#B= 10.0   # plate (or pipe wall) thickness
#W= 70.0   # plate width
#ri= 200.   # Internal diameter if pipe problem. Igno
#azero= 1.5  # initial crack depth
#czero= 4.0  # initial 1/2 crack width at surface
#L= 10.     # Weld Feature width.  Ignored  if ACTIV

#HISTORYFILE=  ps-m40.txt     # historyFileName
#    # Adjustments to load file variables:
#    # Note that the MEANADD (below) is added....
#MAGFACTOR_m= 1.0    # Multiply factor on memb
#MAGFACTOR_b= 1.0    # Multiply factor on bendi
#MEANADD_m=   0.0    # Mean shift in MPa added .
#MEANADD_b=   0.0    # Mean shift in MPa added
...
...
```

Step 3. Provide a file for **crack initiation** calculations.
Ghahremani in his MSc thesis did not provide crack initiation test data, so we will use an approximation; specifically a data set for A36 steel which has similar carbon content but lower yield stress. It is a periodic overload (POL) data set.

Fitted initiation file for dowload:
https://fde.uwaterloo.ca/FatigueClass/Chap10Using/merged_a36_w_POL_fitted.html.txt
(Note: remove the ".txt" suffix using rename or mv)

Place the name in the pdprop.env file

```
#
#MATERIAL= merged_a36_w_POL_fitted.html      #(initiation only)
#                      This file is used to define the cyclic
#                      stress-strain curve, and the Neuber Product curve.
#Kt= 2.0          # Presently for crack initiation calcs only.
#
```

For a good weld use a stress concentration of 2.

Step 4.: Specify crack propagation curve: da/dn vs ΔK information

Generally it is easiest to provide about 10 digitized points that are on your best estimate of the da/dn curve to use. Straight line interpolations between the points are made during the simulations.

If you are using a file of digital points place the word "table" here.

```
….
#
#DADN= table      # Enter:  "table" or "Paris"
#
#DADN_PARIS= 0.0    0.0    0.0   0.0   none   #(ignored if #DADN=  table )
#                    Kth      a       m    Kc   units
#                      !! For units specify:   mpa_m   or   ksi_in  or  mpa_mm
#                      ksi_in: ksi stress, inch crack length, inches in delta_K
#                      mpa_m:  mpa stress,    m crack length, meters in delta_K
#                      mpa_mm: mpa stress,   mm crack length, mm in delta_K
#                                                same as N/(mm**(3/2)
#
#DADN_TABLE=   g40.21-350W.dadn    # da/dN digitized da/dN curve,
#                       (ignored when  #DADN=   PARIS  )
#                        includes digital   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.
...
```

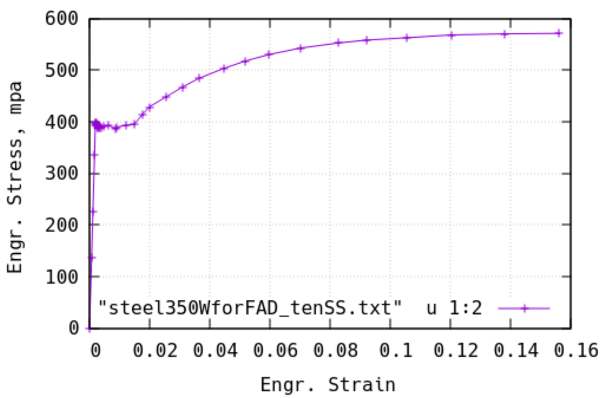
In this example we will use Ghahremani's da/dn curve of which there is a digital text file available. Download:

g40.21-350W.dadn.txt

remove the ".txt" suffix from the filename.

Then enter the filename here.

Step 5: Provide a tensile test stress-strain curve for the FAD (Failure Assessment Diagram) if available. BS 7910: "The vertical axis of a FAD is a ratio of the applied conditions, in fracture mechanics terms, to the conditions required to cause fracture, measured in the same terms. The horizontal axis is the ratio of the applied load to that required to cause plastic collapse."



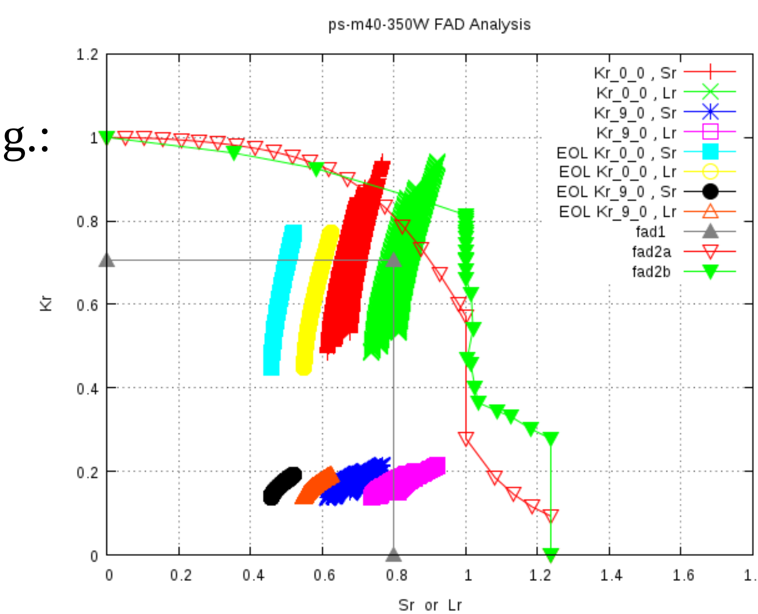
Download
steel350WforFAD_tenSS.txt
and place name here

If no file is available
enter none here.

```
…
#FAD Stuff:
#TensileFile= steel350WforFAD_tenSS.txt     #enter none if no FAD
#PmEOL= 200.        #Set these so that Pm+Pb= 0.82*Syield for default.
#PbEOL= 90.             ( "EOL" implies End Of Life )
#Kmat= 4300.
#PinJoint= 0         #Set = 1 if structure is pin-Jointed (for bending)
#
...
```

BS 7910: "If a valid K_{IC} is available Kmat should be taken as K_{IC} "

FAD e.g.:



For further explanation of the FAD please refer to BS 7910:2005 Section 7 : "Assessment for fracture resistance"

Step 6 : Define the specimen/problem type and
activate the necessary finite width etc. modification factors.

Mm and **Mb** are stress intensity magnification factors for membrane and bending.

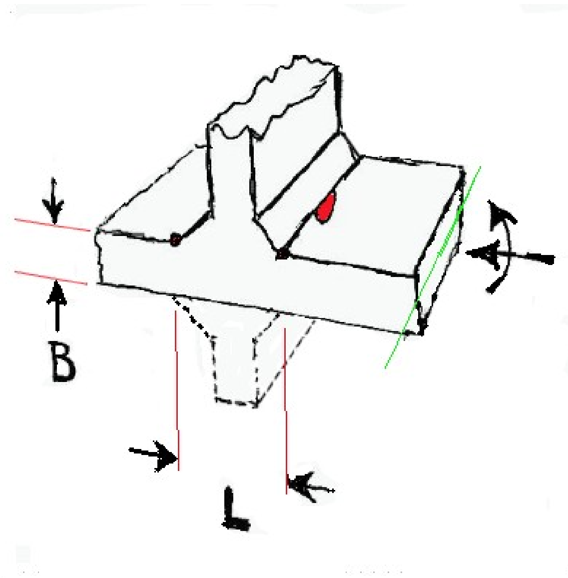
Mkm and **Mkb** are stress intensity magnification factors in the presence of stress raisers; in this case due to the weld.

fw is a finite width correction factor for elliptical flaws.

```
#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
#                        # pipe_full_inside_flaw
#                        # pipe_full_outside_flaw
#                        #
#                        # rod_surface_flaw
#                        # rod_full_outside_flaw

#                        # These problem types are used to pull in the
#                        # appropriate Fw, Mm, Mb, files etc.
```

Step 7: Define the specimen dimensions,
the initial crack size, and
the weld feature size L.



…
The factors described in this section may be ignored if not applicable to
the particular problem type described above.
(All dimensions in mm)

#B= 9.5   # plate (or pipe wall) thickness
#W= 30.0   # plate width
#ri= 00.   # Internal diameter if pipe problem. Ignored if not pipe
#azero= 1.5 # initial crack depth
#czero= 4.0 # initial 1/2 crack width at surface
#L= 22.3   # Weld Feature width. Ignored if ACTIVATE_MkmMkb= 0 (above)
’’’

Step 8: Run the setup check script. In this case : setup1

./setup1

It will check some of your files and parameters in pdprop.env for correct format. The script asks the user questions and allow the user to make changes if required. It also creates the tables for Mm, Mb etc for your given geometry and problem type. At the end of this script you will get some text as to how to run the simulation. It would be a good idea to read over the script now.

Step 9: Run the simulation. The general format of this command is :

./plateWeldflaw scaleFactor <loadHistory >outputFile

By changing the scaleFactor you can increase or decrease the stresses in the load history. e.g.:

./plateWeldflaw 0.95 <load1.txt >plateXYZout0.95

or

./plateWeldflaw 0.90 <load1.txt >plateXYZout0.90

In our case we can run the simulation, after the previous steps with the command:

./plateWeldflaw 1.0 <ps-m40.txt >ps-m40-350W-POL

If you expect lots(millions) of cycles check the size of the output file as the simulation is running with the command:

ls -lt | head -12

in another terminal window. The output file contains information about every half cycle and this file may get bigger than what you would like.

Step 10: After the simulation has ended you can generate a report using the makereport script.

```
./makereport1   outputfile
```

In our example case:

```
./makereport1   ps-m40-350W-POL
```

The makereport scripts read the random access output file and create a number of plots and text information. The plots will appear as files in your present folder, as will an HTML file that gathers the plots into a report format. If the system program "htmldoc" is present the script will also create a pdf file of the report.

e.g. pdf report:

ps-m40-350W-POL.pdf