FractureLab

DATA POSTPROCESSOR SOFTWARE

USER MANUAL

8 July 2026

Contents

Introduction

This is the manual for using the FractureLab postprocessor software to analyze and plot crack growth data from input files generates by the FractureLab controller program. It is also capable of converting older ASCII input files of the .in3 and .in4 format to compatible format for processing.

Additional information about accepted specimen types and respective crack length and stress intensity solutions are provided in the controller manual.

Menu

- "Load XML Input File" loads a crack growth input file in the XML format. The input can be from a static (tensile or K1C), cyclic fatigue, or cyclic fatigue crack growth test. This file type is generated automatically by the FractureLab crack growth controller program after each test segment is complete, and contains all of the information associated with that test. General information, dimensional data, crack length / stress intensity lookup tables, and output data are organized into categories with individual headers and tags for parsing by the postprocessor program.
- "Append XML Input File" loads an additional data set and appends it to the first. This is for analyzing multiple segments of the same test specimen, as identical parameters such as specimen dimensions and crack length / stress intensity factor lookup tables are being used.
- "Import Specimen Info from .log File" allows the user to re-build the controller input file using the automatically-generated log file from the controller. This is especially useful if for some reason the test shut down prematurely and the .xml file was not generated.
- "Import FLCGS .csv File" is used in combination with the log file import option, and brings in the data from the "data snapshot" file generated during program / test recovery.
- "Import Lookup Table" is a useful function that can be selected after the initial input file is loaded or created, and replaces the default solutions that were part of the original input file.
- "Update Lookup Table" is for situations where the initial input is either incomplete after translation from another source or needs to be corrected, resulting in the need for an updates crack length or K solution lookup table.
    - Running the analysis automatically executes an update command if certain dimensional parameters (B, W, gauge length, etc. – any value that would change the relationship between PD/compliance and crack length, or crack length and K) were changed.
    - This command does not overwrite any user-created lookup table provided to either the controller during test or to the postprocessor.
- "Convert from ASCII .inX Input File" is an optional feature to convert the .in3 and .in4 type output files from legacy controller / postprocessor software to a FractureLab-compatible XML input file.
- "Slope Calc (.csv File)" imports a two column comma delimited file with X and Y data which is loaded into the slope calculator segment of the postprocessor for analysis. This is generally used as a precursor to performing a fracture toughness analysis.
- "Save Input File" saves the information in the GUI to an XML input file.
- "Reset Fields" clears the GUI of input and resets all of the options.
- "Quit" exits the program.

Help

- "Manual" opens up a .PDF file of the latest version of the user manual.

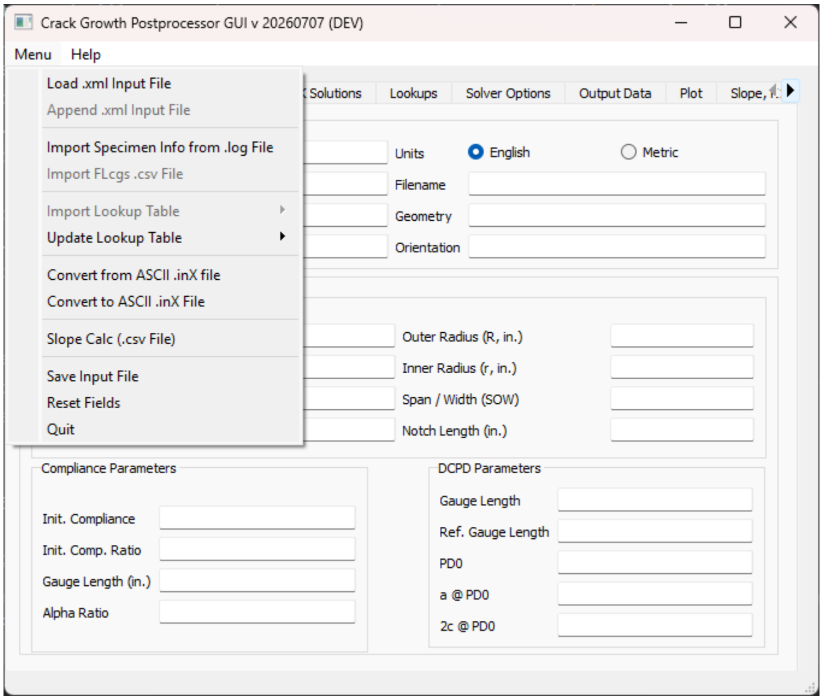


Figure 1: Postprocessor Main Menu

Processing a Standard XML input file

Note that this section is written with the focus on fatigue crack growth test specimen input data. Static specimen metadata will also be loaded and displayed per the description below, but the available selection of analysis options are limited to compact tension and single edge notch bending. The solver and plot options in this section are only applicable to fatigue crack growth as well.

Menu → load XML input file: the GUI will be populated with the information parsed from the input file. A review of the data in each tab is below; it is the responsibility of the engineer to verify all of the imported information is accurate and correct.

- The "Spec. Info" tab contains both general and dimensional information about the test specimen, and is split into three subsections:
  - "Record Information": displays the general test specimen information fields / "metadata" fields:
    - Specimen number with test segment suffix; the segment letter or number was provided at the start of the test in the FL controller program in the controller tab.
    - Contract name or number
    - Test date
  - Below the record information is the "Dimensions" subsection with the physical dimensions of the specimen:

        - Thickness B (in)
        - Net thickness B_{net} (in): this value is different from width B only for specimens with edge notches.
        - Width W (in)
        - Height (in)
        - Span over Width (SOW): the ratio of span to width for bending specimens.
        - Notch Length (in)
    - The last section will either have either the "Compliance Parameters" or "DCPD Parameters" fields active depending on the type used to measure the crack during the test.
        - Compliance Parameters
            - Initial compliance: the compliance measured at the start of the test; used to calculate K associated with adjusted compliance ratio (ACR)
            - Initial compliance ratio (CR_i): the average of full range compliance values divided by the open crack compliance average. As with initial compliance, this is used to calculate ΔK_{ACR}.
            - Gage length
            - Alpha Ratio: the ratio of displacement location to width W.
        - DCPD Parameters
            - Gage Length: the length between the Active PD leads
            - Ref. Gauge Length: the length between the Reference PD leads
            - PD0: the initial DCPD value at a specified crack length.
            - a@PD_0: the crack length at PD_0

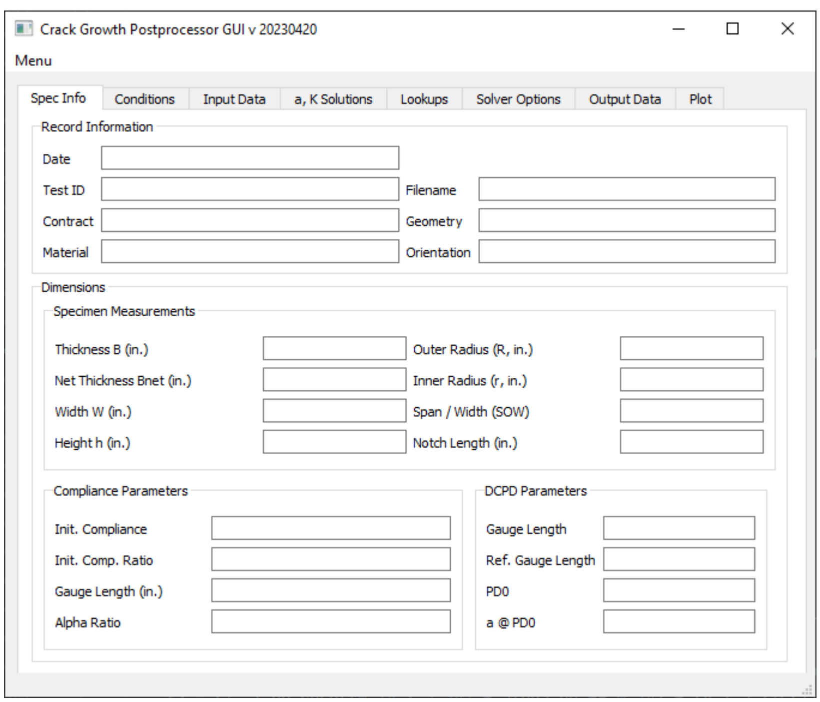


Figure 2: "Spec Info" Tab with Sample Data Showing DCPD Parameters

- The "Conditions" tab contains the pre-crack, environmental, and test control groups.

- The test type radio button indicates the type of crack length measurement used during test. This value and others below are shown for illustrative purposes only and are not editable.
- Pre-Crack Information
  - Load (lbs.): maximum precrack load
  - Stress Ratio: pre-crack stress ratio (P_{min} / P_{max})
  - Crack length (in.): the crack length a at the end of the pre-crack segment
- Environmental
  - Environment: description of the test environment (air, helium, argon, etc.)
  - Temperature (F)
  - Elastic Modulus (psi)
  - Yield Strength (psi): this will be used to calculate net section yield in later iterations of the code.
- Test Control
  - As with test type, the Control Type and K Control Mode options show the user the test control type (load or K) and control mode (constant R or constant K_{max}) but are not selectable as they represent the test conditions.
  - The remaining section contains the test segment conditions:
    - Reference Compliance / DCPD
    - Max. Load
    - Stress ratio
    - Frequency
    - Initial crack length (in)
    - Initial K_{max} (kri)
    - Initial ΔK (kri)
    - K gradient (kri / in)

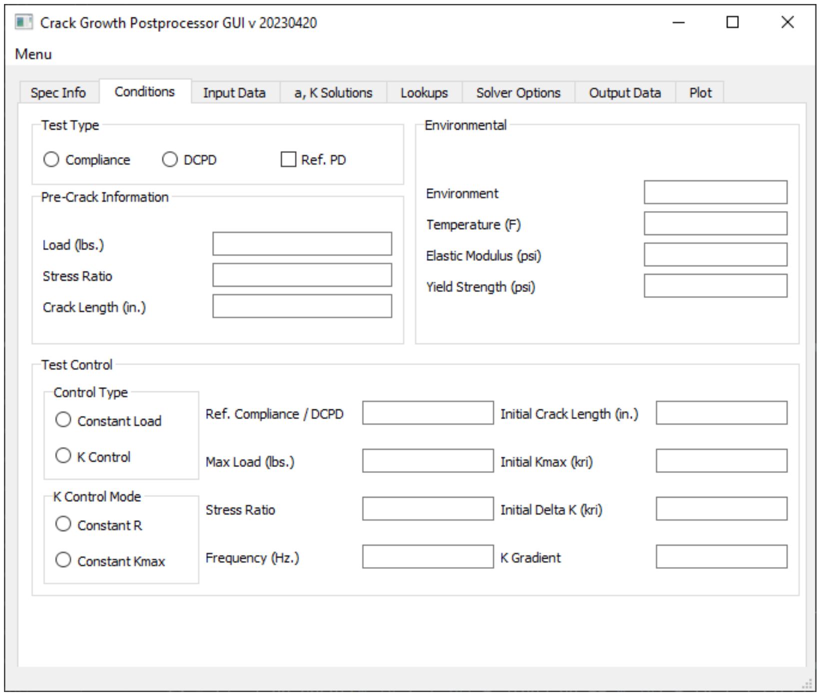


Figure 3: "Conditions" Tab

- The “Input Data” tab displays a table of the test data read in from the input file. This provides an opportunity to visualize the raw input data and also to check the data for any potential errors. It contains the following data columns:
  - Index: the row number of the RAW data set. These values remain constant to indicate that some rows may have been excluded by the user during postprocessing.
  - Exclude: column containing a flag (0 or 1) indicating that the row should be excluded from analysis and output. Default value is set to 0.
  - Skip: similar to “exclude” this column has a flag that indicates whether the code should skip da/dN and K analysis for this row. However, it will still be included in the output file.
  - Pmax: maximum load
  - Pdelta: load range
  - Cyclecount: cycle count at which the output was generated.

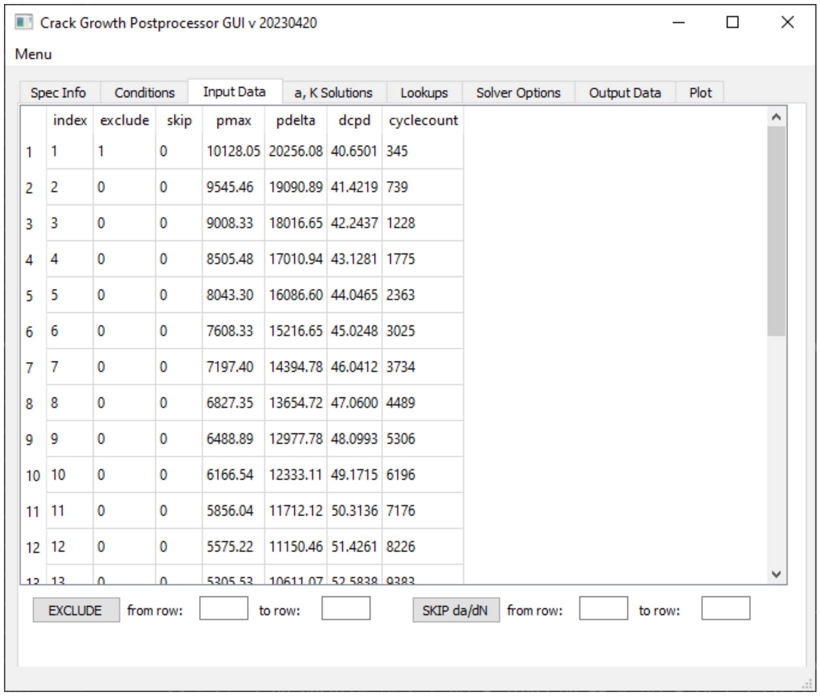


Figure 4: "Input Data" Tab with Sample Excluded and Skipped Rows

To exclude or skip data from the analysis, select the data range adjacent to the desired command using the row number to the left of the data index, and hit either "EXCLUDE" or "SKIP". The indices within the given range will change value in the "exclude" and "skip" columns respectively. If a group of rows containing both excluded and non-excluded data is selected, the flags will switch values from 0 to 1 and vice versa.

- The "a, K Solutions" tab displays the type of crack length calibration method and K solution used during the test. The crack length calibration equations are:
  - Polynomial: a crack length calibration equation in the form of a polynomial that can either be user specified or pre-defined in the case of a compact tension specimen.
  - Johnson's solution: a DCPD crack length solution for edge cracks. Commonly used for SEN (single edge notch) specimens, they may also be used for C(T) specimens that use DCPD for crack measurement.
  - Lookup Table: a user defined, headerless table of either normalized compliance or DCPD (PD / PD_0) and normalized crack length alpha (a/W)
  - Surface Crack / simplified Roe-Coffin: iterative normalized PD solution to determine crack length for a surface crack.
- The K solution options are:
  - C(T) Polynomial: also known as "Polynomial 1" in the FTA postprocessing software, this is the ASTM standard polynomial K solution for compact tension specimens.
  - Eccentrically loaded single edge crack specimen ESE(T): solution for the eccentrically loaded single edge crack specimen
  - Center Crack: the solution for the Middle Tension (M(T)) Specimen under pin load, uniform stress, or uniform displacement loading.
  - Corner Crack: solution for a corner crack specimen.

- Polynomial 2: A more generic form of the Polynomial 1; not yet experimentally verified.
- SEN Polynomial 3: solution for SEN with buttonhead grips
- SEN Rigid: solution for a SEN specimen under rigid grips.
- SEN Pin Loaded: solution for a pin loaded SEN specimen
- Surface Crack (FTA): surface crack solution described by J.K. Donald in the FTA postprocessor.
- Surface Crack (Newman Raju): alternate surface crack K solution derived by J. Newman and I. Raju.
- Flat Bottom Hole: solution for a unique specimen design created by R.G. Pettit to minimize remote closure.

As of September 2025, all K solutions with the exception of corner crack, Polynomial 2, and SEN Rigid solutions have been validated against real-world input files.

Additionally, the only two solution available for K1C analysis are C(T) and SEN(B).

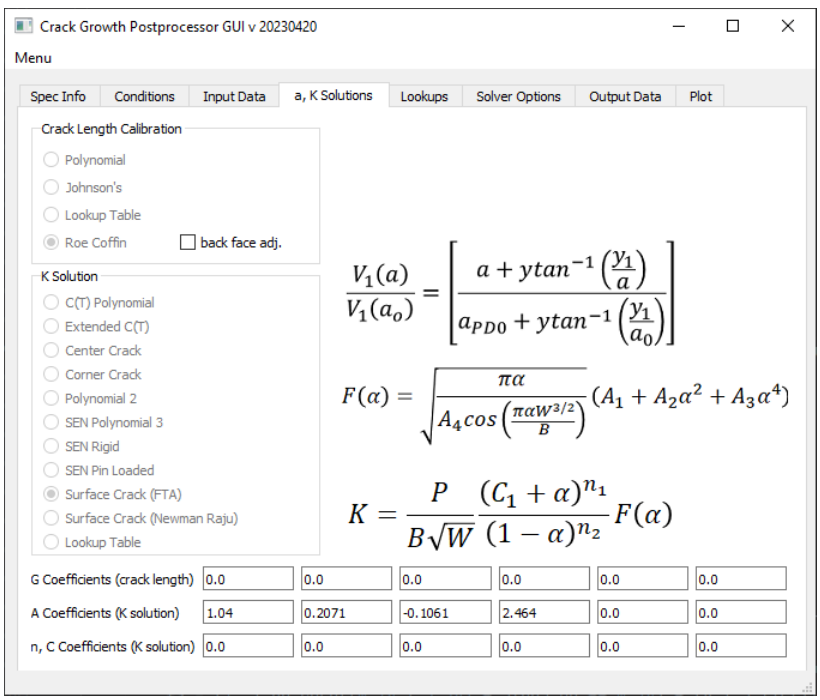
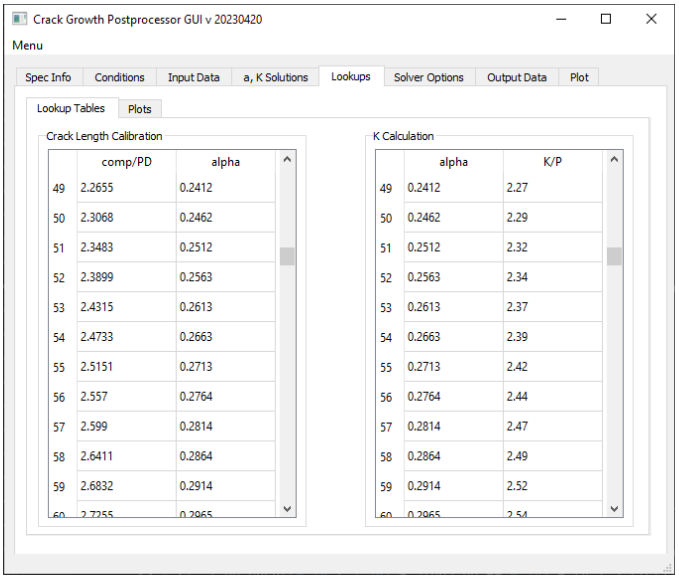
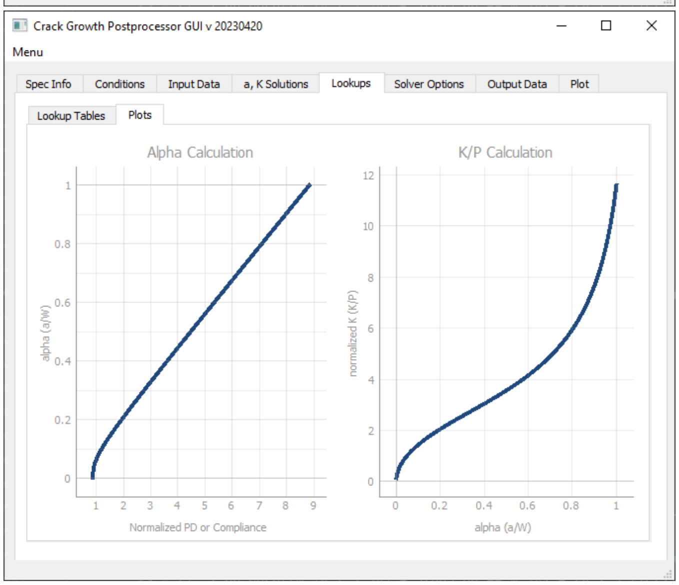


Figure 5: "a, K Solutions" Tab Showing Solution for a Single Edge Notch Specimen

- On the right is a graphical display of the equations and a list of coefficients in displayed on the bottom. There is the option to change the coefficient fields, but as with the test / control type and control mode, the crack length and K solution options themselves are static and not selectable. (Note: The Newman Raju crack length solution is not displayed in the postprocessor but is available in the appendix of this document, as the constituent equations are too large and numerous to be realistically displayed in the space provided.)
- The “Lookups” tab gives the user the ability to visualize the equations used for crack length and stress intensity calculations. Information is provided in tabular and graphical format for ease of use, and allows for a rapid “sanity check” of the input file. Identical information is available in the controller software.





- The "Solver Options" tab (FCGR only) provides options for visual measurement corrections, a table with the visual measurement data, selections for calculating the crack growth rate, normalized K, and parameters for threshold da/dN fitting.
  - The first section – "Crack Length Adjustment" – allows the user to input a set of measured crack lengths and their corresponding compliance or PD values and tell the postprocessor to adjust the calculated crack lengths to the observed difference. The adjustment can be constant, which is useful if there is only one measurement available. If there are more than one measurement, the user can select the "Linear" option, which will create an adjustment factor that varies as a function of compliance or PD value. The error and recalculated crack lengths corresponding to the visual measurements are displayed after the analysis is complete. Options are available to add and delete rows to accommodate possible outliers and generate a more consistent adjustment factor for the entire ligament.
    - "da/dN Analysis Options" provide a selection of the standard methods to calculate crack growth rate. They are defined as follows:

- Secant: calculation based on the current and previous values of crack length and cycle count:

$$\frac{da}{dN} = \frac{a_i - a_{i-1}}{N_i - N_{i-1}}$$

- Modified secant: calculation based on the next and previous values of crack length and cycle count:

$$\frac{da}{dN} = \frac{a_{i+1} - a_{i-1}}{N_{i+1} - N_{i-1}}$$

- 7 Point Polynomial: method developed to fit a second order polynomial to the a vs. N data to calculate crack growth rate. The formulation can be found in ASTM E647 Table X1.1. The result of using this approach is an overall smoother fit, which can be useful if there is a higher than usual amount of noise in the data. Because of the nature of the fitting routine, the leading and trailing three data points are not fit and have values of 0. Generally this method is used in conjunction with the modified secant method as described below.
- Modified Secant / 7 Point Combo: a combination of the 7 point polynomial for the body of the data and the modified secant for the three points at the head and tail of the data set, thus "filling in the blanks" left by the 7 point calculation. This is generally favored over the standalone 7 point polynomial method to generate more complete data.

▪ Closure Calculations: crack growth specimens with large ligaments such as C(T) specimens will experience remote closure in the threshold regime if the applied stress ratio is small enough ($\leq$ approx. 0.4). This will result in an increase in threshold K relative to closure-free, small crack behavior, and must be corrected. The opening load (OP) and partial opening load ($2/\pi$) calculations are available if closure data was recorded during the test. A drop down menu allows for the option of selecting normalized load values at various percentages (1%, 2%, 4%, 8%, 16%) as the basis for correcting for remote closure. The adjusted compliance ratio (ACR) method is available as long as an initial compliance / compliance ratio are recorded. Generally, the ACR method is more effective in collapsing specimen data with varying degrees of closure.

▪ "K norm Calculations": this option, if enabled, normalizes the K values to stress ratio using the Walker formulation, which is an alternate closure model to the NASGRO-based Newman Closure formulation. Each curve normalized using this approach is collapsed R = 0 using an "effective K"; the result is a "master curve" that can be used to generate any da/dN vs. K curve at positive R. The exact value of the coefficient needs to be externally calculated through iteration with a number of other data sets at different stress ratios.

▪ "Threshold da/dN Fit Calculations: provide the parameters for an option Paris curve fit to the Region I (threshold) portion of the data. Upper and lower range limits along with the interpolation point can be user specified, but the ASTM standard values are automatically populated by default. Options are available for fitting curves to $\Delta K_{applied}$ as well as ΔK_{ACR} and K_{norm}.

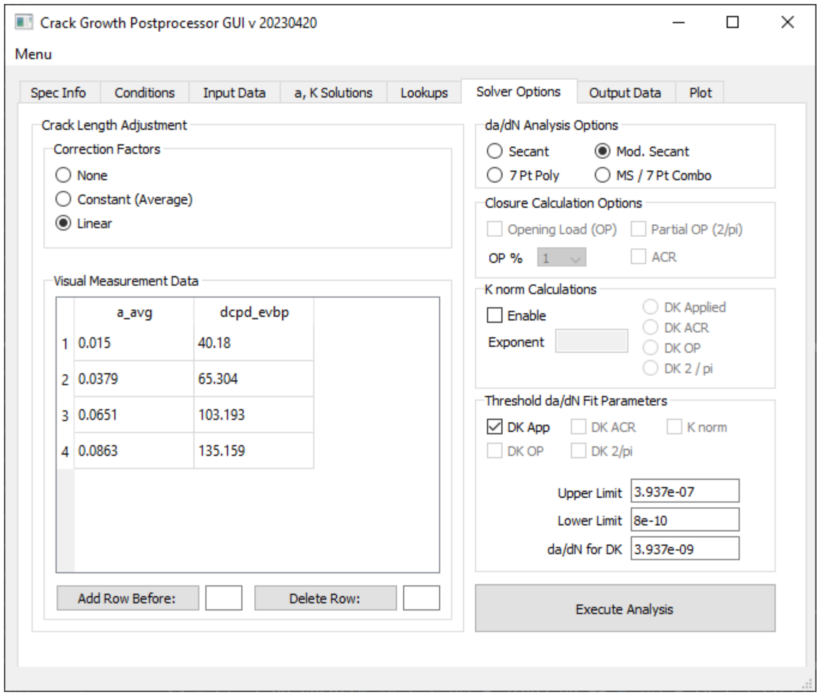
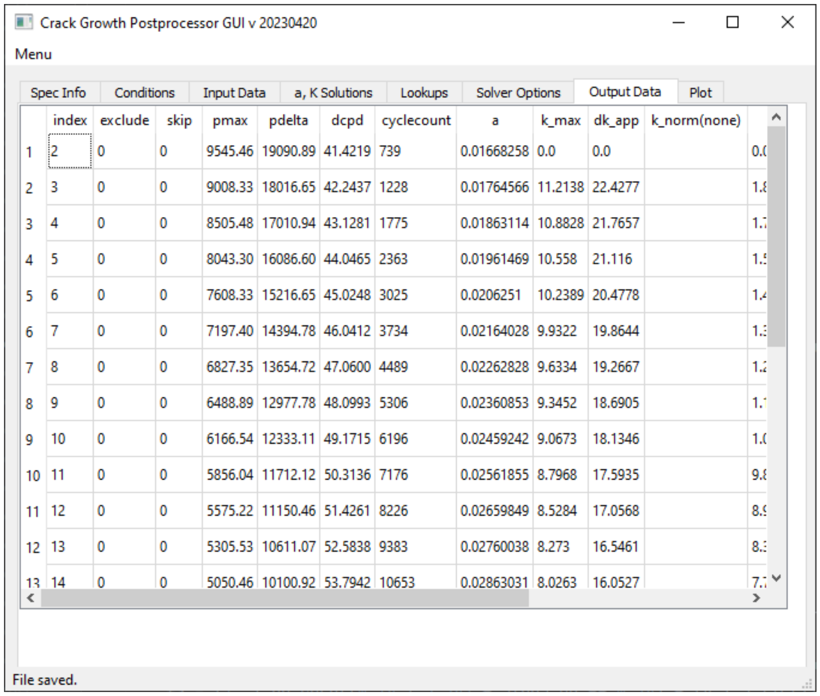


Figure 6: "Solver Options" Tab with Visual Data

- "Execute Analysis" runs the crack growth analysis with the input values provided. Upon execution, the Visual Measurement Data table is populated with the corrected visuals (If Constant or Linear correction was selected), and "Output Data" tab displays the input data along with the analysis results:
  - a: crack length
  - k_max: maximum stress intensity factor (applied)
  - dk_app: applied DK
  - k_norm(xxx): normalized K value; can be based on either applied or ACR K values.
  - da/dN: crack growth rate



	index	exclude	skip	pmax	pdelta	dcpd	cyclecount	a	k_max	dk_app	k_norm(none)
1	2	0	0	9545.46	19090.89	41.4219	739	0.01668258	0.0	0.0	
2	3	0	0	9008.33	18016.65	42.2437	1228	0.01764566	11.2138	22.4277	
3	4	0	0	8505.48	17010.94	43.1281	1775	0.01863114	10.8828	21.7657	
4	5	0	0	8043.30	16086.60	44.0465	2363	0.01961469	10.558	21.116	
5	6	0	0	7608.33	15216.65	45.0248	3025	0.0206251	10.2389	20.4778	
6	7	0	0	7197.40	14394.78	46.0412	3734	0.02164028	9.9322	19.8644	
7	8	0	0	6827.35	13654.72	47.0600	4489	0.02262828	9.6334	19.2667	
8	9	0	0	6488.89	12977.78	48.0993	5306	0.02360853	9.3452	18.6905	
9	10	0	0	6166.54	12333.11	49.1715	6196	0.02459242	9.0673	18.1346	
10	11	0	0	5856.04	11712.12	50.3136	7176	0.02561855	8.7968	17.5935	
11	12	0	0	5575.22	11150.46	51.4261	8226	0.02659849	8.5284	17.0568	
12	13	0	0	5305.53	10611.07	52.5838	9383	0.02760038	8.273	16.5461	
13	14	0	0	5050.46	10100.92	53.7942	10653	0.02863031	8.0263	16.0527	

Figure 7: "Output Data" Tab

- The "Plot" tab displays the crack growth rate as a function of applied DK and DK_{ACR} or K_{norm}, depending on whether the appropriate calculations were made. If threshold fits were selected, the coefficients will be shown in the corresponding fields. "Plotting Options" gives the user the flexibility to select any combination of the data and threshold fits for better visualization.

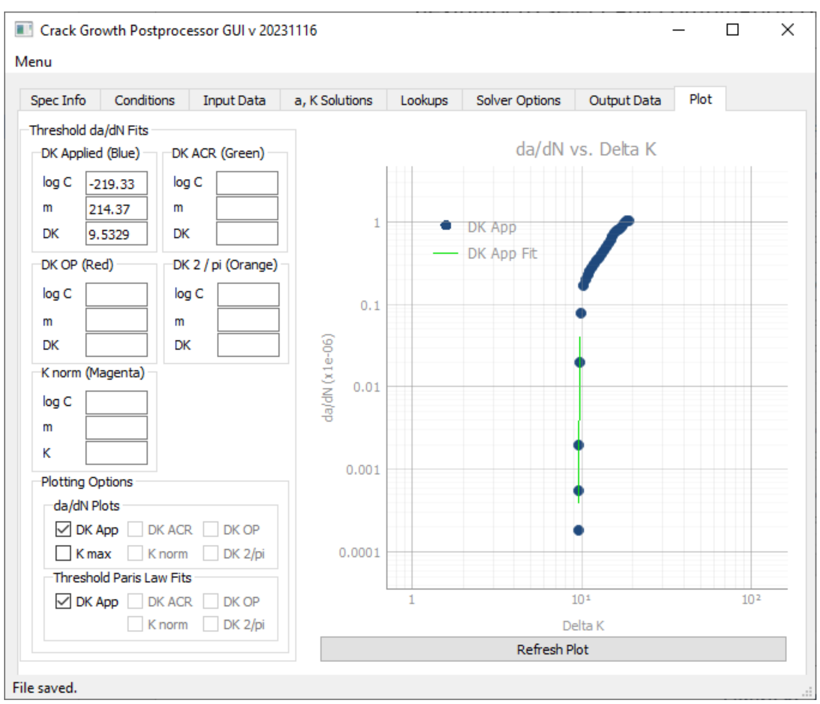


Figure 8: "Plot" Tab with Threshold Fit for Applied DK

Processing a static .XML input file

Loading a static input file will also prompt the postprocessor to load all of the metadata associated with the static test. Information such as loading conditions, temperature, environment, specimen dimensions, and specimen number / type will be populated, provided they were supplied at the time the test was run.

This section is also applicable for the "Slope Calc (.csv File)" menu option as it will import the same X-Y data.

- The "Slope / K1C" tab: this section is only used during analysis of static test results. When the user loads a static test type (either .xml or .csv), the postprocessor will automatically populate the "Plot: Original Dataset" tab with the raw data and activate it. The metadata fields described in the previous sections will only be populated if an .xml file is loaded, as a generic X-Y .csv file does not contain this information.
- "Calculate Slope" performs a slope analysis on the linear segment of the imported data, according to the method outlined in ASTM E3067: "Standard Practice for Determining the Slope in the Linear Region of a Test Record".

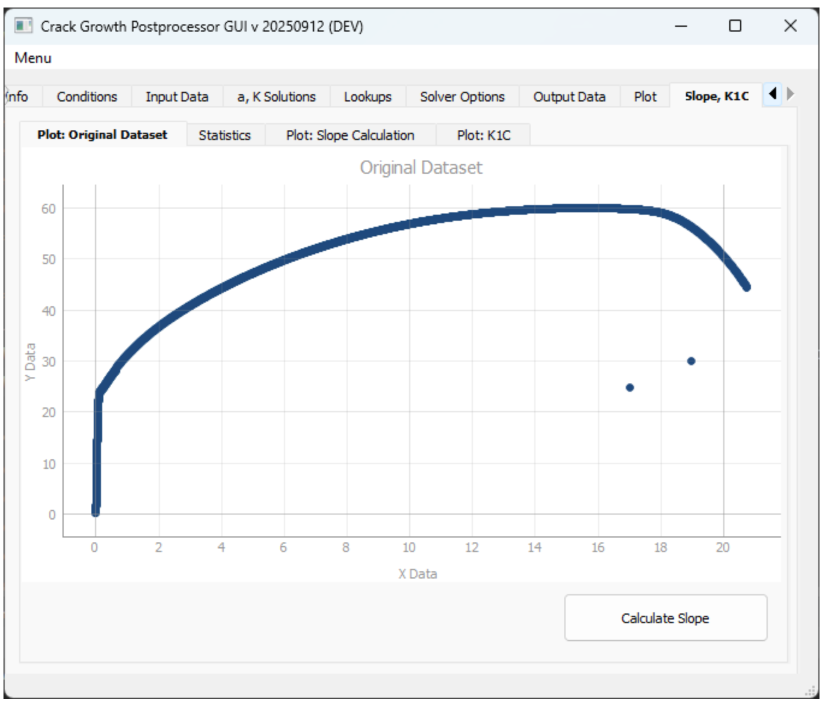


Figure 9: "Plot: Original Dataset" Tab withStatic Data

- The "Statistics" tab shows the results of the linear analysis per E3076. Data and fit quality metrics are listed in the order in which they are conducted within the standard. Results are compared to the standard acceptance criteria and are flagged if outside the acceptable range. The "EXPORT" option prints the results of the raw data, statistics, and slope calculation plot tabs to a PDF file.

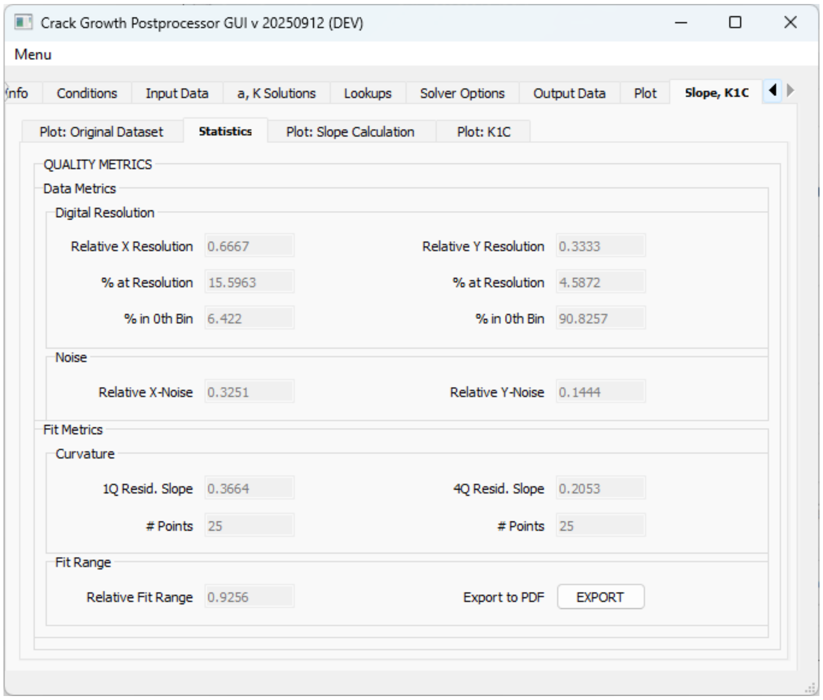


Figure 10: "Statistics" Tab with Linear Fit Results

- The "Plot: Slope Calculation" tab shows the graphical results of the linear regression. A section of the original static tensile curve up to the point of yield is shown superimposed onto the segment of the data that was calculated to be most representative of the linear portion of the test. Slope and intercept along with the upper and lower Y bounds are shown in text fields below the plot.

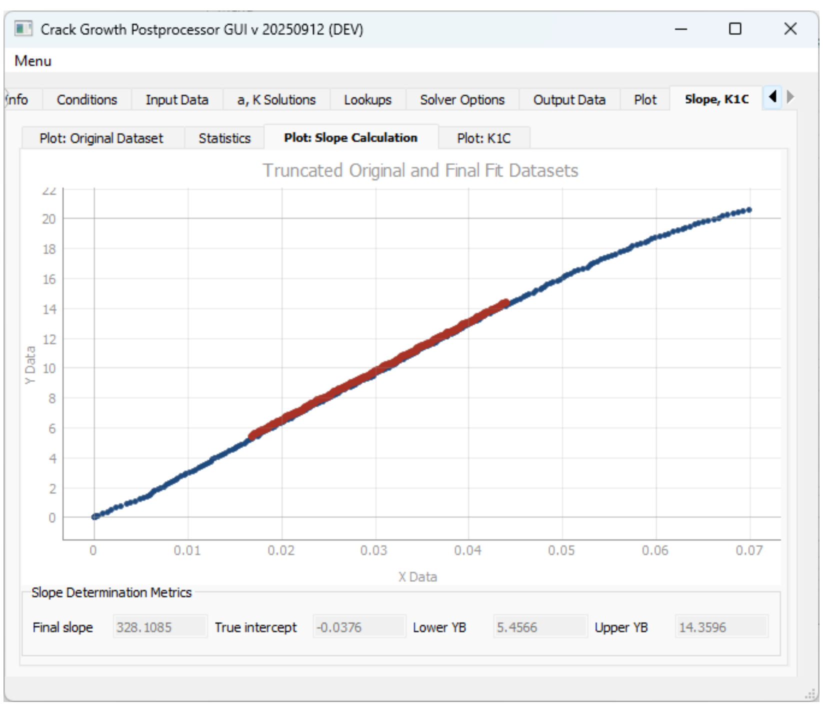


Figure 11: "Plot: Slope Calculation" Tab with Linear Fit Results

- If the input file is for a fracture toughness test rather than a simple tensile test result, the "Slope, K1C" tab can be used to input the specimen type, dimensions, and units to execute a K1C analysis per ASTM E399: "Standard Test Method for Linear Elastic Plane Strain Fracture Toughness K_{1C} of Metallic Materials".

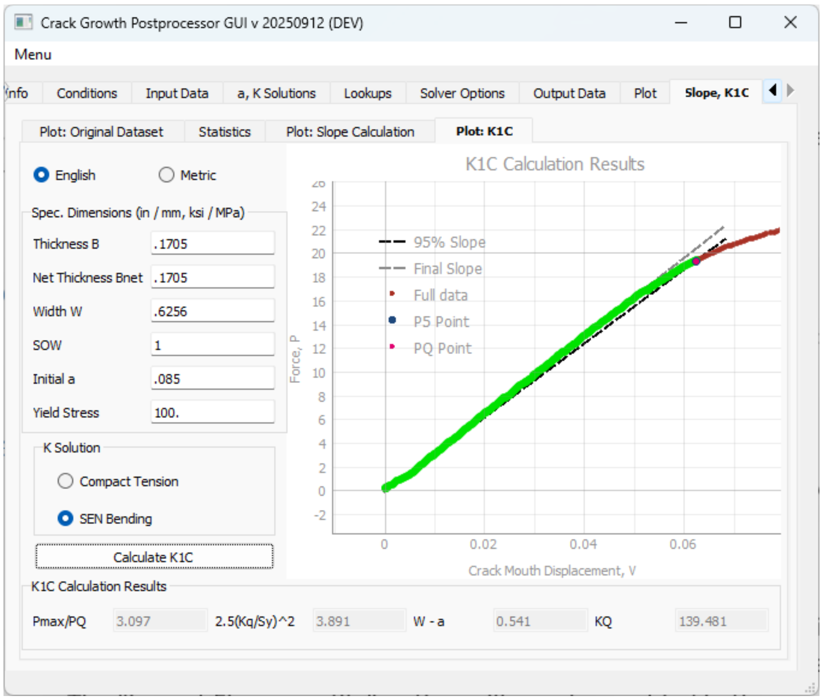


Figure 12: "Plot: K1C" Tab with Fracture Toughness Results and Plot

- After the analysis, a plot is shown of the portion of the data that was used for the analysis along with the calculated slope per ASTM E3076, a projection of 95% of the calculated slope, the specimen load at the intersection of the raw data and the 95% projection (P5), and the maximum load within that range (PQ). In the example shown above, both the P5 and PQ point are coincident.

Creating an Input Deck

There are a number of ways to generate input for postprocessing; this section will review them in more detail.

Loading an .XML input file

- Select Menu → Load .xml input file (described in the previous section)

Recovering from Log Files

This is a two-part process to import and convert text based test data and convert it to an XML input file.

Part 1: Importing the .log File

- Select Menu → Import specimen info from .log file
- Select the log file for the test to be postprocessed. Generally, during recovery, this file will be the "recovery.log" file. Once imported, the general specimen information fields will be populated.

- The “import FLcgs .csv file” option will now be enabled in the menu.

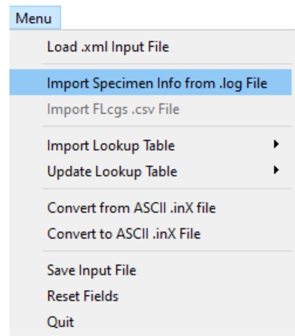


Figure 9: Import Specimen Info From .log File Option

Part 2: Importing the .csv File

- Select Menu → Import FLcgs .csv file
- Select the “DATA_RECOVERY_SNAPSHOT.csv” file that was generated during the recovery process. Once imported, the test data will be populated for postprocessing.
- Once complete, select “Save Input File” to save to an .xml file and postprocess as usual.

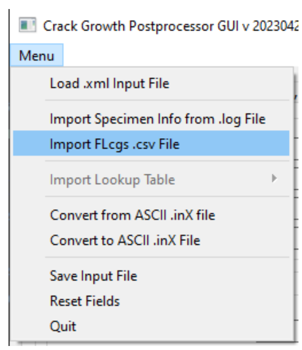


Figure 10: Import .csv File Option

Convert ASCII files

The postprocessor code has the capability to import ASCII input files and convert them to FractureLab-compatible XML based input files for processing.

- Select Menu → convert ASCII file
- Locate the .in3 or .in4 file to be converted and either double click or press “OK”
- It will then provide the user the option to Save As an XML file type. Select a filename and hit “OK”
- In the case of importing .in3 files, it is necessary to add visual crack measurements if crack length adjustment is desired.
- Proceed with the analysis as described in the previous section.

Importing Lookup Tables

The option to import a lookup table for either crack length or stress intensity is enabled after loading an .xml input file or importing data from a .log / .csv file combination. The import process is identical for both calculation types:

- Select Menu → Import Lookup Table → [Crack Length / K Solution]
- Locate the .csv lookup table file to be converted and either double click or press “OK”
- The software will then update the corresponding plot and table with the imported file.

Save Input File

The Save command exports the data in the GUI fields – including the input data – into an XML format file.

Quit

Exits the program.