

# **QUICK FATIGUE TOOL FOR MATLAB®**

## **User Settings Reference Guide**



# Version Information

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# 1. Job file options

## 1.1 Background

The job file contains a list of options which define a specific analysis. The options are separated into the following categories:

1. Job
2. Material
3. Loading
4. High frequency loadings
5. Abaqus RPT / data set file
6. Analysis
7. Surface finish / notch effects
8. Virtual strain gauges
9. Output requests
10. ODB Interface
11. BS 7608 weld definition
12. Additional material data

Job files are created either from the template located in *Project/job/template\_job.m*, or from a user-defined text file. Guidance on creating and submitting jobs for analysis is provided in Section 2.4 “Configuring and running an analysis” of the *Quick Fatigue Tool User Guide*.

If the user modified the template job file and wishes to revert back to the original, a back-up template is contained in *Application\_Files/default/default\_job.m*.

## 1.2 Job file options table

The following table provides a description of each option in the job file.

Option	Description
JOB_NAME	<p>The name of the job, also the name of the corresponding output directory.</p> <p><i>Job file usage:</i> JOB_NAME = '&lt;job_name&gt;';</p>
JOB_DESCRIPTION	<p>A short description of the analysis. Note that a summary of the job settings is automatically written to the log file.</p> <p><i>Job file usage:</i> JOB_DESCRIPTION = '&lt;job_description&gt;';</p>
CONTINUE_FROM	<p>The name of the job onto which field data from the current job will be superimposed.</p> <p><i>Job file usage:</i> CONTINUE_FROM = '&lt;job_name&gt;';</p>
DATA_CHECK	<p>Aborts the job just before the start of the fatigue analysis.</p> <p><i>Job file usage:</i> DATA_CHECK = n;</p> <p>n has the following definitions: 0: Do not perform Data Check analysis 1: Perform a Data Check analysis</p>
MATERIAL	<p>The material used for the analysis. The file extension <i>.mat</i> can be omitted. The material must exist in the following directory:</p> <p><i>Data/material/local</i></p> <p><i>Job file usage:</i> MATERIAL = '&lt;material_name&gt;.mat';</p>

USE\_SN Controls whether stress-life data is being used for the analysis.

*Job file usage:*  
USE\_SN =  $n$ ;

$n$  has the following definitions:  
0: Derived ( $S_f'$  and  $b$ )  
1: Direct (S-N data points)

(Refer to section 4 for detailed job file usage)

SN\_SCALE Scales S-N stress data points.

*Job file usage:*  
SN\_SCALE =  $n$ ;

$n$  is a real number.

SN\_KNOCK\_DOWN S-N knock-down curve for S-N data points.

*Job file usage:*  
SN\_KNOCK\_DOWN =  $n$ ;

$n$  is a real number.

DATASET The file, or files, containing the stress data for the analysis.

*Job file usage for simple loading:*  
DATASET = '<fea\_definition>.rpt';

(Refer to section 3 for detailed job file usage)

HISTORY The file, or files, containing the load history data for the analysis.

*Job file usage for a simple loading:*  
HISTORY = '<history\_data>.dat';

(Refer to section 3 for detailed job file usage)

## UNITS

Units for the stress data.

*Job file usage:*

UNITS =  $n$ ;

$n$  has the following definitions:

0: User-defined

1: Pa

2: kPa

3: MPa

4: psi

5: ksi

6: Msi

## CONV

Conversion factor for user-defined units.

*Job file usage:*

CONV =  $n$ ;

$n$  is the conversion factor between Pascal [Pa] and the user-defined unit.

## LOAD\_EQ

Unit of measurement to which the complete loading definition is equal.

*Job file usage:*

LOAD\_EQ = {  $n$ , '<unit>' };

$n$  is the number of repeats that the loading is equivalent to, expressed by the units <unit>. By default, the loading is equivalent to 1 repeat.

## SCALE

Load history scale factors.

*Job file usage for a single load history:*

SCALE =  $n$ ;

$n$  is a real number.

*Job file usage for multiple load histories:*

SCALE = [ $n_1, n_2, \dots, n_i$ ];

$i$  is the number of load histories.



OFFSET	<p>Load history offset values.</p> <p><i>Job file usage for a single load history:</i>  OFFSET = <math>n</math>;</p> <p><math>n</math> is a real number.</p> <p><i>Job file usage for multiple load histories:</i>  OFFSET = [<math>n_1, n_2, \dots, n_i</math>];</p> <p><math>i</math> is the number of load histories.</p>
REPEATS	<p>The number of repeats of the loading.</p> <p><i>Job file usage:</i>  REPEATS = <math>n</math>;</p> <p><math>n</math> is a real number.</p>
HF_DATASET	<p>The file, or files, containing high frequency stress data sets.</p> <p><i>Job file usage for simple loading:</i>  HF_DATASET = '&lt;hf_dataset&gt;.rpt';</p> <p>(Refer to section 3 for detailed job file usage)</p>
HF_HISTORY	<p>The file, or files, containing high frequency load history data.</p> <p><i>Job file usage for a simple loading:</i>  HF_HISTORY = '&lt;hf_history&gt;.dat';</p> <p>(Refer to section 3 for detailed job file usage)</p>
HF_TIME	<p>The time period for the low and high frequency data sets.</p> <p><i>Job file usage:</i>  HF_TIME = <math>\{t_1, t_2\}</math>;</p> <p><math>t_1</math> is the time period of the low frequency data  <math>t_2</math> is the time period of the high frequency data</p>

HF\_SCALE

A scale factor for the entire loading.

*Job file usage for a single load history:*

HF\_SCALE =  $n$ ;

$n$  is a real number.

HF\_SCALE is used in the same way as SCALE

PLANE\_STRESS

Specifies whether the input file reader should recognise data set files containing plane stress elements.

*Job file usage:*

PLANE\_STRESS =  $n$ ;

$n$  has the following definitions:

0: Allow data set files with 3D stress elements only. Combinations of 2D/3D elements will not be recognised

1: Allow data set files with plane stress elements. Combinations of 2D/3D elements will be recognised

OUTPUT\_DATABASE

Associates an analysis with an Abaqus output database (.odb) file. If the stress data set(s) were created from an Abaqus model, Quick Fatigue Tool will attempt to write field data back to the .odb file specified.

*Job file usage:*

OUTPUT\_DATABASE = '<odb\_name>.odb';

Where <odb\_name> is the full (absolute) path to the Abaqus .odb file.

PART\_INSTANCE

The part instance in the Abaqus model to which field data should be written.

*Job file usage:*

PART\_INSTANCE = '<part\_instance\_name>;

Multiple part instances may be specified as a cell:

*Job file usage:*

PART\_INSTANCE = {'<instance\_1>', ..., '<instance\_n>'};

EXPLICIT\_FEA

The analysis procedure which was used to calculate the FE stresses. If the results step originates from an Abaqus/Explicit analysis, the proceeding step must also be Explicit. Quick Fatigue Tool requires this information from the user in order to write fatigue results back to the ODB file.

*Job file usage for Explicit FEA:*

EXPLICIT\_FEA = 1.0;

*Job file usage for all other FEA types:*

EXPLICIT\_FEA = 0.0;

STEP\_NAME

The name appended to the results ODB step. This option is not compulsory, but minimizes the risk of naming clashes which would prevent Quick Fatigue Tool from successfully writing field data to the .odb file.

*Job file usage:*

STEP\_NAME = '<step\_name>';

RESULT\_POSITION

Results position of the exported field data.

*Job file usage:*

RESULT\_POSITION = ['ELEMENT NODAL' | 'UNIQUE NODAL' |  
'INTEGRATION POINT' | 'CENTROID'];

GROUP

Defines analysis groups for the use of individual properties to user-defined regions.

*Job file usage:*

GROUP = {'<group\_1>.rpt',..., '<group\_n>.rpt'};

## ALGORITHM

The algorithm used for analysis.

*Job file usage:*

ALGORITHM =  $n$ ;

$n$  has the following definitions:

0: Default

1: [Reserved for future release]

2: [Reserved for future release]

3: Uniaxial Stress-Life

4: Stress-based Brown-Miller (CP)

5: Normal Stress (CP)

6: Findley's Method (CP)

7: von Mises

8: BS 7608

9: [Reserved for future release]

10: [Reserved for future release]

11: [Reserved for future release]

If  $n = 0$ , the default algorithm from the material properties will be used.

## MS\_CORRECTION

The mean stress correction used for analysis.

*Job file usage:*

MS\_CORRECTION =  $n$ ;

$n$  has the following definitions:

0: Default

1: Morrow

2: Goodman

3: Soderberg

4: Walker

5: Smith-Watson-Topper

6: Gerber

7: R-ratio S-N curves

8: None

If  $n = 0$ , the default mean stress correction from the material properties will be used.

If the mean stress correction is user-defined, it is specified by its file name.

*Job file usage:*

MS\_CORRECTION = '<mscFilename>.msc';

## ITEMS

The list of items for analysis.

*Job file usage:*

ITEMS = [ $n_1$ ,  $n_2$ , ...,  $n_i$ ];

Each value in ITEMS references a row number in the stress definition file, and is not necessarily the same as the position number (if the stresses originate from an Abaqus .rpt file).

To analyse all items in the model:

ITEMS = 'ALL';

To analyse items from hotspots:

ITEMS = 'hotspots\_<jobname>.dat';

## DESIGN\_LIFE

The life at which the component meets its fatigue design criterion.

*Job file usage:*

DESIGN\_LIFE =  $n$ ;

$n$  is the design life is repeats ( $N_f$ ). To set the design life as the material's constant amplitude endurance limit:

DESIGN\_LIFE = 'CAEL';

If the analysis contains multiple group definitions, the constant amplitude endurance limit is taken from the material defined in the last group.

KT\_DEF

Surface finish definition. A value of  $K_t$  can be specified directly, or a  $K_t$  surface finish definition file can be provided.

*Job file usage:*

KT\_DEF =  $n$ ;

$n$  is a positive, real number. To calculate  $K_t$  from a file, specify the file name:

KT\_DEF = '<filename>.kt';

If the option is left empty, a  $K_t$  value of 1.0 will be assumed:

KT\_DEF = [ ];

KT\_CURVE

Used to specify the  $K_t$  curve corresponding to a particular surface treatment, or a surface roughness value,  $R_z$ :

*Job file usage:*

KT\_CURVE =  $n$ ;

If the surface finish is selected from a list,  $n$  is a positive integer. The maximum value of  $n$  depends on how many curves are defined in the .kt file. If the option is left empty, the first curve in the .kt will be used:

KT\_CURVE = [ ];

If the surface finish is defined as a value,  $n$  is a positive real number specifying the surface roughness.

NOTCH\_CONSTANT

Material constant defining the relationship between the elastic stress concentration factor and the fatigue notch factor. Depending on the value of [notchSensitivityMethod](#), the constant is either the characteristic length or the notch sensitivity.

*Job file usage:*

NOTCH\_CONSTANT =  $n$ ;

$n$  is a real number.

NOTCH\_RADIUS

Notch root radius to calibrate the notch sensitivity estimation.

*Job file usage:*

NOTCH\_RADIUS =  $n$ ;

$n$  is a real number.

RESIDUAL

Specifies an in-plane residual stress component in the loading. The stress is assumed to act uniformly in all directions.

*Job file usage:*

RESIDUAL =  $n$ ;

$n$  is a real number. Positive values of  $n$  correspond to a tensile residual stress, while negative values are compressive.

FACTOR\_OF\_STRENGTH

Enable Factor of Strength (FOS) iterations.

*Job file usage:*

FACTOR\_OF\_STRENGTH =  $n$ ;

$n$  has the following definitions:

1: Enable FOS iterations

0: Disable FOS iterations

## FATIGUE\_RESERVE\_FACTOR

Material life envelope expressed for Fatigue Reserve Factor calculations.

*Job file usage:*

FATIGUE\_RESERVE\_FACTOR =  $n$ ;

$n$  has the following definitions:

1: Goodman (Default)

2: Goodman B

3: Gerber

If the proof stress is not defined and the Goodman B envelope is specified, the standard Goodman envelope will be used by default.

For user-defined envelopes, the FRF data (.msc) file is specified.

*Job file usage:*

FATIGUE\_RESERVE\_FACTOR = '<fileName>.msc';

## HOTSPOT

Save items below the design life to a separate file. This file can be used in conjunction with ITEMS to re-analyse the model only for items which failed the previous design life criterion.

*Job file usage:*

HOTSPOT =  $n$ ;

$n$  has the following definitions:

1: Enable hotspots

0: Disable hotspots

## GAUGE\_LOCATION

Define virtual gauges to simulate a rectangular rosette strain gauge at selected analysis items.

*Job file usage:*

GAUGE\_LOCATION = {' $m_1.s_1$ ', ' $m_2.s_2$ ', ..., ' $m_n.s_n$ '};

' $m_n.s_n$ ' is the main and sub position ID of the location of gauge  $n$ . The IDs must be separated by a decimal point.

For integration point or element-nodal positions,  $m_n$  is the element number and  $s_n$  is the integration point/node number.

For centroidal or unique nodal positions,  $m_n$  is the centroid/node number.  $s_n$  is always 1.0.



GAUGE_ORIENTATION	<p>Define gauge orientations for virtual strain gauges.</p> <p><i>Job file usage:</i>  GAUGE_ORIENTATION = {[<math>\alpha_1</math>, <math>\beta_1</math>, <math>\gamma_1</math>], [<math>\alpha_2</math>, <math>\beta_2</math>, <math>\gamma_2</math>],..., [<math>\alpha_n</math>, <math>\beta_n</math>, <math>\gamma_n</math>]};</p> <p><math>\alpha_n</math> is the angle measured counter clockwise from the positive global (Cartesian) x-direction to rosette arm <i>A</i> of gauge <i>n</i>.</p> <p><math>\beta_n</math> is the angle measured counter clockwise from rosette arm <i>A</i> to <i>B</i> of gauge <i>n</i>.</p> <p><math>\gamma_n</math> is the angle measured counter clockwise from rosette arm <i>B</i> to <i>C</i> of gauge <i>n</i>.</p> <p>Angles are measured in degrees.</p> <p>Define gauge orientations using flags.</p> <p><i>Job file usage:</i>  GAUGE_ORIENTATION = {'RECTANGULAR'   'DELTA'};</p>
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OUTPUT_FIELD	<p>Field data output request.</p> <p><i>Job file usage:</i>  OUTPUT = <i>n</i>;</p> <p><i>n</i> has the following definitions:  1: Write field output  0: Life at worst item only</p>
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OUTPUT_HISTORY	<p>History data output request.</p> <p><i>Job file usage:</i>  OUTPUT = <i>n</i>;</p> <p><i>n</i> has the following definitions:  1: Write history output  0: No history output</p>
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OUTPUT\_FIGURE

MATLAB figure output request.

*Job file usage:*

OUTPUT =  $n$ ;

$n$  has the following definitions:

1: Create MATLAB figures for histories

0: No MATLAB figures

WELD\_CLASS

Define the  $S_r - N$  curve for the BS 7608 analysis algorithm in terms of weld class.

*Job file usage:*

WELD\_CLASS =  $n$ ;

WELD\_CLASS = '<Weld identifier>';

$n$  is an integer corresponding to one of the ten BS 7608  $S_r - N$  curves:

1: B

2: C

3: D

4: E

5: F

6: F2

7: G

8: W

9: S

10: T

11: X (Axially loaded bolts)

Alternatively, <Weld identifier> may be used to reference the curve designation directly as a string value.

The  $S_r - N$  curve may be defined as user data.

*Job file usage:*

WELD\_CLASS = {'<userCurveFile>.sn', ['ROW' | 'COL']}

If the second argument is omitted, column-wise data is assumed.

YIELD\_STRENGTH

The user-specified yield stress of the weld plate material for BS 7608 analysis.

*Job file usage:*

YIELD\_STRENGTH =  $n$ ;

$n$  is a real number.

UTS

The user-specified ultimate tensile strength of the bolt section for BS 7608 analysis, when using Class X.

*Job file usage:*

UTS =  $n$ ;

$n$  is a real number.

DEVIATIONS\_BELOW\_MEAN

The number of deviations below the mean S-N curve family for BS 7608 analysis, used to specify the probability of failure.

*Job file usage:*

DEVIATIONS\_BELOW\_MEAN =  $n$ ;

$n$  is a positive integer.

FAILURE\_MODE

The crack initiation criterion for BS 7608 analysis.

*Job file usage:*

FAILURE\_MODE =  $n$ ;

FAILURE\_MODE = ['NORMAL' | 'SHEAR' | 'COMBINED'];

$n$  has the following definitions:

1: Normal failure

2: Shear failure

3: Combined (normal + shear) failure

CHARACTERISTIC\_LENGTH

The plate thickness for all weld classifications (or bolt diameter for axially loaded bolts), used to correct the S-N curve for BS 7608 analysis.

*Job file usage:*

CHARACTERISTIC\_LENGTH =  $n$ ;

$n$  is a positive real number.

The length units are *mm*. The option should set empty if the characteristic length is not important:

CHARACTERISTIC\_LENGTH = [ ];

SEA\_WATER

Specifies whether the welded feature is exposed to sea water for BS 7608 analysis.

*Job file usage:*

SEA\_WATER =  $n$ ;

$n$  is 1 or 0.

B2

Secondary Basquin's exponent used above a user-defined knee point.

*Job file usage:*

B2 =  $n$ ;

$n$  is less than zero.

B2\_NF

Life above which the secondary Basquin's exponent (B2) is used.

*Job file usage:*

B2\_NF =  $n$ ;

$n$  is greater than zero.

UCS

The material ultimate compressive strength.

*Job file usage:*

UTS =  $n$ ;

$n$  is a real number.

## 2. Environment variables

### 2.1 Background

The environment file contains a list of variables which define the general behaviour of Quick Fatigue Tool. Environment variables are applied *globally* and *locally*. Global environment variables define the behaviour of the program for all analysis jobs executed in the current Quick Fatigue Tool directory, whereas local environment variables define the behaviour of the program for a specific job.

### 2.2 Global environment file

The global environment variables are contained in *Application\_Files/default/environment.m*. Changes made to this file will affect all jobs submitted in the current working directory. In the event that the user wishes to revert to the original environment settings, a list of environment variables with their default values can be found in *Application\_Files/default/default\_environment.m*.

### 2.3 Local environment files

Local environment variables may be defined for a particular job. This is done by making a copy of the global environment file and placing it in *Project/job*. Alternatively, the user may create a blank text file and specify only the environment variables they wish to define for that job. However, for the analysis to run properly, the global environment file must always be available.

The local environment file must obey the naming convention *<jobName>\_env.m*, otherwise it will not be processed by Quick Fatigue Tool.

### 2.4 Processing of environment variables

At the beginning of each analysis, Quick Fatigue Tool searches *Application\_Files/default* for the global environment file. It then searches *Project/job* for the local environment file. Local environment settings supersede global environment settings.

Before each analysis, it is compulsory for all environment variables to be defined. Even if the user specifies non-default values in a local environment file, the global environment file must still exist and contain all of the variables. If the global environment file is modified or lost, and the default environment file is no longer available, the fastest way to recover the settings is to re-download the application from the MATLAB File Exchange.

## 2.5 Environment variables table

The following table provides a description of each variable in the environment file.

Variable	Description
gateTensors	<p>Controls whether the peak-valley analysis algorithm is used for tensors.</p> <p><i>Environment file usage:</i> setappdata(0, 'gateTensors', n);</p> <p>n has the following definitions: 0: Off 1: Gate tensors (as % of max tensor) 2: Gate tensors (Nielsony's method)</p>
tensorGate	<p>Tensor gating values.</p> <p><i>Environment file usage:</i> setappdata(0, 'tensorGate', n);</p> <p>n has the following definitions: 0: Zero-derivative method N: % of max tensor</p>
gateHistories	<p>Controls whether the peak-valley analysis algorithm is used for load histories.</p> <p><i>Environment file usage:</i> setappdata(0, 'gateHistories', n);</p> <p>n has the following definitions: 0: Off 1: Pre-gate load histories (as % of max tensor) 2: Pre-gate load histories(Nielsony's method)</p>

### historyGate

Load history gating values.

*Environment file usage:*

```
setappdata(0, 'historyGate', n);
```

n has the following definitions:

0: Zero-derivative method

N: % of max tensor

### noiseReduction

Noise reduction algorithm applied to load history.

*Environment file usage:*

```
setappdata(0, 'noiseReduction', n)
```

n is 1.0 or 0.0.

### numberOfWindows

Number of averaging windows used by the noise reduction algorithm.

*Environment file usage:*

```
setappdata(0, 'numberOfWindows', n)
```

n is a positive integer.

### groupDefinition

Controls how Quick Fatigue Tool should treat a group definition file.

*Environment file usage:*

```
setappdata(0, 'groupDefinition', n);
```

n has the following definitions:

0: Program controlled

1: Always read group data as an FEA subset

<b>modifiedGoodman</b>	<p>Defines the envelope for the Goodman mean stress correction.</p> <p><i>Environment file usage:</i>  setappdata(0, 'modifiedGoodman', n);</p> <p>n has the following definitions:  0: Use the standard Goodman envelope  1: Use the intersection of the Buch with the Goodman envelope</p>
<b>goodmanMeanStressLimit</b>	<p>Defines the horizontal (mean stress) axis intercept for the Goodman mean stress correction.</p> <p><i>Environment file usage:</i>  setappdata(0, 'goodmanMeanStressLimit', [n   'string']);</p> <p>n has the following definitions:  'UTS': Use the material UTS  'PROOF': Use the material proof stress  'S-N': Use the S-N intercept stress (at 1 repeat)  n: User-defined</p> <p>User-defined values are not supported if the modified Goodman envelope is selected.</p>
<b>walkerGammaSource</b>	<p>Controls how the Walker gamma parameter is calculated.</p> <p><i>Environment file usage:</i>  setappdata(0, 'walkerGammaSource', n);</p> <p>n has the following definitions:  1: Calculate the gamma parameter from the Walker regression fit  2: Use Dowling's approximation for steel and aluminium  3: User-defined</p>
<b>userWalkerGamma</b>	<p>User-defined value of the Walker gamma parameter if <b>walkerGammaSource</b> = 2.0.</p> <p><i>Environment file usage:</i>  setappdata(0, 'userWalkerGamma', n);</p> <p>n is a real number, positive number.</p>



### rainflowAlgorithm

Selects the rainflow cycle counting algorithm.

*Environment file usage:*

```
setappdata(0, 'rainflowAlgorithm', n);
```

n has the following definitions:

1: De Morais (Legacy)

2: Vallance

The second version is a more recent implementation and has been found to produce much better results. The original algorithm is available for regression and testing purposes.

### rainflowMode

Specify the order of operations for the selected rainflow algorithm for two-parameter cycle counting.

*Environment file usage:*

```
setappdata(0, 'rainflowMode', n);
```

n has the following definitions:

1: Combine parameters, count cycle

2: Count parameters, combine cycles

This setting currently only applies to the Stress-based Brown-Miller algorithm.

### shellLocation

Sets the default face from which to read shell element stresses.

*Environment file usage:*

```
setappdata(0, 'shellLocation', n);
```

n has the following definitions:

1: LOC 1 (SNEG)

2: LOC 2 (SPOS)

#### nlMaterial

Controls which material model is used for the analysis.

*Environment file usage:*

```
setappdata(0, 'nlMaterial', n);
```

n has the following definitions:

0: Linear (Hookean) material model

1: Nonlinear elastic (Ramberg-Osgood) material model

A linear elastic material model is acceptable for most stress-based analyses. Use with caution.

#### cssTolerance

Precision of the iterative Ramberg-Osgood solver for the nonlinear material model.

*Environment file usage:*

```
setappdata(0, 'cssTolerance', n);
```

n is a positive real number.

#### cssMaxIterations

Maximum number of iterations performed by the iterative Ramberg-Osgood solver before accepting the solution.

*Environment file usage:*

```
setappdata(0, 'cssMaxIterations', n);
```

n is a positive integer.

#### nodalElimination

Controls whether the nodal elimination algorithm is being used for analysis.

*Environment file usage:*

```
setappdata(0, 'nodalElimination', n);
```

n has the following definitions:

0: Analyse all nodes

1: Nodal elimination based on material's CAEL

2: Nodal elimination based on user design life

#### thresholdScaleFactor

A factor which scales the conditional stress,  $\sigma_{COND}$ , for the nodal elimination algorithm.

*Environment file usage:*

```
setappdata(0, 'thresholdScaleFactor', n);
```

n is a real number. The default value is 0.8.

#### yieldCriterion

Perform static strength yield calculations.

*Environment file usage:*

```
setappdata(0, 'yieldCriterion', n);
```

n has the following definitions:

0: Do not perform yield calculations

1: Perform yield calculations based on the total strain energy theory

2: Perform yield calculations based on the shear strain energy theory

#### stepSize

The step size for the critical plane analysis algorithm.

*Environment file usage:*

```
setappdata(0, 'stepSize', n);
```

n must be a factor of 180. The default step size is 15 degrees.

#### checkLoadProportionality

Enables load proportionality checking to determine if the critical plane step size may be increased.

*Environment file usage:*

```
setappdata(0, 'checkLoadProportionality', n);
```

n has the following definitions:

0: Use step size defined by **stepSize**

1: Check for load proportionality and increase the step size to 45 degrees if applicable

### proportionalityTolerance

The tolerance angle for the load proportionality check. The load is considered to be proportional if the maximum deviation in the principal directions does not exceed this angle.

*Environment file usage:*

```
setappdata(0, 'proportionalityTolerance', n);
```

n is an angle in degrees. The default tolerance angle is 1 degree.

### cpSample

The re-sample rate for the critical plane analysis plots.

*Environment file usage:*

```
setappdata(0, 'cpSample', n);
```

n is a real number.

The re-sample rate only affects the smoothness of the MATLAB figure data. It does not affect the tabulated data from which the plots are created.

### cpShearStress

Specify how the maximum shear stress history is determined on the critical plane.

*Environment file usage:*

```
setappdata(0, 'cpShearStress', n)
```

n has the following definitions:

1: Maximum chord method

2: Maximum resultant shear stress

### signConvention

The default sign convention for effective stress quantities.

When using the Stress-Based Brown-Miller, Normal Stress, Findley's Method or BS 7608, the effective stress quantity is the resultant shear stress on the critical plane. When using the von Mises algorithm, the effective stress quantity is the von Mises stress.

*Environment file usage:*

```
setappdata(0, 'signConvention', n);
```

n has the following definitions:

1: Sign from the hydrostatic stress

2: Sign from the largest stress

### nasalifeParameter

The effective stress parameter for the NASALIFE analysis algorithm.

*Environment file usage:*

setappdata(0, 'nasalifeParameter', n);

n has the following definitions:

- 1: Manson-McKnight
- 2: Sines
- 3: Smith-Watson-Topper
- 4: R-Ratio Sines
- 5: Effective

### plasticSN

Specifies which region(s) of the stress-life curve to consider for analysis when using the stress-based Brown-Miller analysis algorithm.

*Environment file usage:*

setappdata(0, 'plasticSN', n)

n has the following definitions:

- 0: Use elastic region of S-N curve only ( $S_f'$  and  $b$ )
- 1: Include plastic region of S-N curve ( $E_f'$  and  $c$ )

### findleyNormalStress

Specify how the normal stress is matched with shear cycles for Findley's Method.

*Environment file usage:*

setappdata(0, 'findleyNormalStress', n)

n has the following definitions:

- 1: Use the maximum normal stress over the loading
- 2: Use the maximum normal stress over the maximum shear cycle interval
- 3: Use the average normal stress over the maximum shear cycle interval

### stressInvariantParameter

Specify the damage parameter for the Stress Invariant Parameter algorithm.

*Environment file usage:*

```
setappdata(0, 'stressInvariantParameter', n)
```

n has the following definitions:

0: Program controlled

1: von Mises

2: Principal

3: Hydrostatic (pressure)

4: Tresca

### nasalifeParameter

Specify the damage parameter for the NASALIFE algorithm.

*Environment file usage:*

```
setappdata(0, 'nasalifeParameter', n)
```

n has the following definitions:

1: Manson-McKnight

2: Sines

3: Smith-Watson-Topper

4: R-Ratio Sines

5: Effective

### ndCompression

Controls whether damage is calculated for compressive cycles.

*Environment file usage:*

```
setappdata(0, 'ndCompression', n);
```

n has the following definitions:

1: No damage in compression

0: Compressive cycles cause damage

The default value of n is 1.

## fatigueLimitSource

Controls how the fatigue limit is calculated.

*Environment file usage:*

```
setappdata(0, 'fatigueLimitSource', n);
```

n has the following definitions:

1: Calculate the fatigue limit from Basquin material coefficients (Sf and b)

2: Calculate the fatigue limit from algorithm-specific equation

3: User-defined

The default value of n is 1. When using Basquin coefficients, the fatigue limit is calculated from  $\sigma_{\infty} = \sigma'_f (CAEL)^b$ , where  $\sigma_{\infty}$  is the fatigue limit stress,  $\sigma'_f$  is the fatigue strength coefficient,  $CAEL$  is the constant amplitude endurance limit ( $2N_f$ ) and  $b$  is the fatigue strength exponent.

The algorithm-specific equations only apply to the Stress-based Brown-Miller and the Findley algorithms.

Stress-based Brown-Miller (without fatigue ductility):

$$\sigma_{\infty} = \sigma'_f (1.65 \times CAEL)^b$$

Stress-based Brown-Miller (with fatigue ductility):

$$\sigma_{\infty} = E \left( \frac{1.65 \sigma'_f}{E} (CAEL)^b + 1.75 \varepsilon'_f (CAEL)^c \right)$$

Findley's method:

$$\sigma_{\infty} = \tau^*_f (CAEL)^b$$

If USE\_SN = 1.0 in the job file, the fatigue limit will be calculated by interpolating the S-N data points, unless a user-defined endurance limit is specified.

#### userFatigueLimit

User-defined value of the endurance limit if **fatigueLimitSource** = 3.0.

*Environment file usage:*

```
setappdata(0, 'userFatigueLimit', n);
```

n is a real number, positive number.

Custom values of the fatigue limit are not supported by the BS 7608 analysis algorithm.

#### ndEndurance

Assumes no damage for cycles below the endurance limit.

*Environment file usage:*

```
setappdata(0, 'ndEndurance', n);
```

n has the following definitions:

0: Program-controlled

1: Calculate damage for cycle below the endurance limit

2: Assume no damage for cycles below the endurance limit

For a detailed explanation of the way Quick Fatigue Tool treats the endurance limit, consult Appendix I: Fatigue analysis techniques.

#### modifyEnduranceLimit

Reduces the endurance limit for damaging cycles.

*Environment file usage:*

```
setappdata(0, 'modifyEnduranceLimit', n);
```

n has the following definitions:

0: Damaging cycles do not affect the endurance limit

1: Damaging cycles reduce the endurance limit to 25% of its original value

#### enduranceScaleFactor

The amount by which the endurance limit is scaled after a damaging cycle, if **modifyEnduranceLimit**=1.

*Environment file usage:*

```
setappdata(0, 'enduranceScaleFactor', n);
```

The default value of n is 0.25.



<b>cyclesToRecover</b>	<p>The number of non-damaging cycles before the endurance limit returns to its original value, if <b>modifyEnduranceLimit</b>=1.</p> <p><i>Environment file usage:</i>  setappdata(0, 'cyclesToRecover', n);</p> <p>n is an integer number of cycles. The default value of n is 50.</p>
<b>fosTarget</b>	<p>Target life for the FOS calculations</p> <p><i>Environment file usage:</i>  setappdata(0, 'fosTarget', n);</p> <p>n has the following definitions:</p> <p>1: Perform FOS calculations for user-defined design life</p> <p>2: Perform FOS calculations for infinite design life (CAEL)</p>
<b>fosMaxValue</b>	<p>The maximum reported value of the FOS.</p> <p><i>Environment file usage:</i>  setappdata(0, 'fosMaxValue', n);</p> <p>n is a real number. The default value of n is 2.</p>
<b>fosMaxFine</b>	<p>The maximum FOS value at which fine increments are performed.</p> <p><i>Environment file usage:</i>  setappdata(0, 'fosMaxFine', n);</p> <p>n is a real number. The default value of n is 1.5.</p>
<b>fosMinFine</b>	<p>The minimum FOS value at which fine increments are performed.</p> <p><i>Environment file usage:</i>  setappdata(0, 'fosMinFine', n);</p> <p>n is a real number. The default value of n is 0.8.</p>

#### fosMinValue

The minimum reported value of the FOS.

*Environment file usage:*

```
setappdata(0, 'fosMinValue', n);
```

n is a real number. The default value of n is 0.5.

#### fosCoarseIncrement

The step size used for FOS iterations outside the fine bands.

*Environment file usage:*

```
setappdata(0, 'fosCoarseIncrement', n);
```

n is a real number. The default value of n is 0.1.

#### fosFineIncrement

The step size used for FOS iterations within the fine bands.

*Environment file usage:*

```
setappdata(0, 'fosCoarseIncrement', n);
```

n is a real number. The default value of n is 0.01.

#### fosMaxCoarseIterations

The maximum number of coarse iterations for the FOS calculation.

*Environment file usage:*

```
setappdata(0, 'fosMaxCoarseIterations', n);
```

n is a positive integer. The default value of n is 4.

#### fosMaxFineIterations

The maximum number of fine iterations for the FOS calculation.

*Environment file usage:*

```
setappdata(0, 'fosMaxFineIterations', n);
```

n is a positive integer. The default value of n is 6.

#### fosTolerance

The percentage tolerance value for the FOS calculation.

*Environment file usage:*

```
setappdata(0, 'fosTolerance', n);
```

n is a real number. The default value of n is 5%.

### fosBreakAfterBracket

Terminates FOS iterations if the most recently calculated life crosses the target life.

*Environment file usage:*

```
setappdata(0, 'fosBreakAfterBracket', n);
```

n has the following definitions:

1: Enable bracketing

2: Disable bracketing

### fosAugment

Enables augmented FOS iterations. If the current FOS increment meets the threshold criterion set by `fosAugmentThreshold`, the increment is scaled by the factor `fosAugmentFactor`.

*Environment file usage:*

```
setappdata(0, 'fosAugment', n);
```

n has the following definitions:

1: Enable augmented iterations

2: Disable augmented iterations

### fosAugmentThreshold

Threshold value for augmented FOS iterations.

*Environment file usage:*

```
setappdata(0, 'fosAugmentThreshold', n);
```

n is a number between 0.0 and 1.0.

### fosAugmentFactor

Scale factor for augmented FOS iterations.

*Environment file usage:*

```
setappdata(0, 'fosAugmentFactor', n);
```

n is a real number.

### fosDiagnostics

Diagnostic output for the FOS calculation.

*Environment file usage:*

```
setappdata(0, 'fosDiagnostics', n);
```

n has the following definitions:

1: Write output

2: Do not write output

### frfInterpOrder

Interpolation order for user-defined FRF data.

*Environment file usage:*

```
setappdata(0, 'frfInterpOrder', '<ARG>');
```

The following strings are accepted for <ARG>:

'NEAREST', 'LINEAR', 'SPLINE', 'PCHIP'.

For a description of each argument, see Section 8.2.5, or type doc [interp1](#) in the MATLAB command window.

### frfNormParamMeanT

Normalization parameter for tensile mean stress user-defined FRF data.

*Environment file usage:*

```
setappdata(0, ['frfNormParamMeanT' | '<param>' | n]);
```

'<param>' has the following definitions:

'UTS': Ultimate tensile strength

'UCS': Ultimate compressive strength

'PROOF': 0.2% Proof stress

n is a user-defined normalization parameter.

#### frfNormParamMeanC

Normalization parameter for compressive mean stress user-defined FRF data.

*Environment file usage:*

```
setappdata(0, ['frfNormParamMeanC' | '<param>' | n]);
```

'<param>' has the following definitions:

'UTS': Ultimate tensile strength

'UCS': Ultimate compressive strength

'PROOF': 0.2% Proof stress

n is a user-defined normalization parameter.

#### frfNormParamAmp

Normalization parameter for stress amplitude user-defined FRF data.

*Environment file usage:*

```
setappdata(0, ['frfNormParamAmp' | '<param>' | n])
```

'<param>' has the following definitions:

'LIMIT': Fatigue limit

n is a user-defined normalization parameter.

#### frfTarget

Target life for the FRF calculations.

*Environment file usage:*

```
setappdata(0, 'frfTarget', n);
```

n has the following definitions:

1: Perform FRF calculations for user-defined design life

2: Perform FRF calculations for infinite design life (CAEL)

#### frfMaxValue

The maximum reported value of the FRF.

*Environment file usage:*

```
setappdata(0, 'frfMaxValue', n);
```

n is a real number. The default value of n is 10.

#### frfMinValue

The minimum reported value of the FRF.

*Environment file usage:*

```
setappdata(0, 'frfMinValue', n);
```

n is a real number. The default value of n is 0.01.

#### frfDiagnostics

Diagnostic output for the FRF calculation when user-defined envelopes are specified.

*Environment file usage:*

```
setappdata(0, 'frfDiagnostics', [I1, I2, ..., In]);
```

n has the following definitions:

[ ]: Disabled

I<sub>n</sub>: Write output for item number I<sub>n</sub> in the data set

#### notchFactorEstimation

Method for approximating the fatigue notch factor based on the elastic stress concentration factor.

*Environment file usage:*

```
setappdata(0, 'notchFactorEstimation', n);
```

n has the following definitions:

1: Peterson (default)

2: Peterson B

3: Neuber

4: Harris

5: Heywood

6: Notch sensitivity

#### eigensolver

Eigensolver used to calculate the principal stress history.

*Environment file usage:*

```
setappdata(0, 'eigensolver', n);
```

n has the following definitions:

1: MATLAB (built-in)

2: Luong

### numberOfBins

The number of range bins used for the rainflow cycle histogram plot, RHIST.

*Environment file usage:*

```
setappdata(0, 'numberOfBins', n);
```

n is a positive integer.

### figureFormat

File format for MATLAB figures.

*Environment file usage:*

```
setappdata(0, 'figureFormat', '<format>');
```

<format> specifies the file format. e.g.:

'fig': MATLAB Figure

'png': Portable Network Graphics

'jpg': JPEG

### fieldFormatString

Specify output format of field output file.

*Environment file usage:*

```
setappdata(0, 'fieldFormatString', '<format>');
```

### historyFormatString

Specify output format of history output files.

*Environment file usage:*

```
setappdata(0, 'historyFormatString', '<format>');
```

### echoMessagesToCWIN

Echo message file contents to the MATLAB command window.

*Environment file usage:*

```
setappdata(0, 'echoMessagesToCWIN', n);
```

n has the following definitions:

1: Enabled

0: Disabled

### cleanAppData

Controls when the session application data should be cleaned.

*Environment file usage:*

```
setappdata(0, 'cleanAppData', n);
```

n has the following definitions:

1: Before the analysis

2: After the analysis

3: Before and after the analysis

4: Never

### workspaceToFile

Cache the workspace variables and associated APPDATA into a MATLAB binary (.mat) file.

*Environment file usage:*

```
setappdata(0, 'workspaceToFile', n);
```

n has the following definitions:

0: Disabled

1: Every n analysis items

2: n evenly spaced analysis items

3: From analysis item IDs

The analysis item interval/IDs are specified with

`workspaceToFileInterval`.

### workspaceToFileInterval

Set the frequency at which workspace variables and APPDATA are written.

*Environment file usage:*

```
setappdata(0, 'workspaceToFileInterval', {n, '<OPTION>'});
```

If `workspaceToFile` = [1.0 | 2.0], n is the interval number.

If `workspaceToFile` = 3.0, n is an analysis item ID list:  $[ID_1, \dots, ID_n]$ .

<OPTION> has the following definitions:

'OVERLAY': Overwrite the cache file. Only the cache file at the last interval/ID is retained.

'RETAIN': Create an individual cache file for each interval/ID.



#### autoExport\_ODB

Enables automatic export of field data to an Abaqus output database (.odb) file.

*Environment file usage:*

```
setappdata(0, 'autoExport_ODB', n);
```

n has the following definitions:

1: Enabled

0: Disabled

#### autoExport\_stepType

Controls whether field output is written to a new ODB step, or an existing step from a previous Quick Fatigue Tool analysis.

*Environment file usage:*

```
setappdata(0, 'autoExport_stepType', n);
```

n has the following definitions:

1: Export results to new step

2: Export results to existing step

#### autoExport\_autoPosition

Allow Quick Fatigue Tool to determine the data position automatically, based on the format of the field data position IDs.

*Environment file usage:*

```
setappdata(0, 'autoExport_autoPosition', n);
```

n has the following definitions:

1: Enabled

0: Disabled

If the data position is already known, a value of 0 is strongly advised.

#### autoExport\_upgradeODB

Specify whether the model ODB file should be upgraded.

*Environment file usage:*

```
setappdata(0, 'autoExport_upgradeODB', n);
```

n has the following definitions:

1: Upgrade the model ODB file

0: Do not upgrade the model ODB file

The Abaqus version to which the model ODB file is upgraded depends on the setting of [autoExport\\_abqCmd](#).

#### autoExport\_abqCmd

Specify the Abaqus API version used by the ODB Interface.

*Environment file usage:*

```
setappdata(0, 'autoExport_abqCmd', '<abaqus_command>');
```

<abaqus\_command> is the name of the batch file used to launch Abaqus and is usually located in <Abaqus\_installation\_directory>/Commands. If the ODB upgrade utility is enabled with autoExport\_upgradeODB, this is the Abaqus version to which the file is upgraded.

#### autoExport\_createODBSet

Write an element or node set to the output database file containing the elements or nodes used for analysis.

If the input stresses are at the unique nodal position, a node set containing these nodes is written to the .odb file.

If the input stresses are at the element-nodal position, both element and node sets containing the element-nodes used for analysis are written to the .odb file.

If the input stresses are at the integration point or centroidal position, an element set constituting the domain of the integration points or centroids is written to the .odb file.

*Environment file usage:*

```
setappdata(0, 'autoExport_createODBSet', 1.0);
```

#### autoExport\_ODBSetName

Name of the ODB element/node set if createODBSet = 1.0. If this variable is left blank, a default name is used, composed of the part instance name and the step name.

*Environment file usage:*

```
setappdata(0, 'autoExport_ODBSetName', [ ]);
```

```
setappdata(0, 'autoExport_ODBSetName', '<name>');
```

**autoExport\_executionMode**

Controls the visibility of the Python script used by the Abaqus API.

*Environment file usage:*

setappdata(0, 'autoExport\_executionMode', n);

n has the following definitions:

- 1: Create ODB, discard Python script
- 2: Create ODB, retain Python script
- 3: Write Python script only

**autoExport\_selectionMode**

Output variable selection type.

*Environment file usage:*

setappdata(0, 'autoExport\_selectionMode', n);

n has the following definitions:

- 1: Select the output variables from a list
- 2: Use preselected defaults
- 3: Select all available output variables

If  $n = 1$ , the output variable selection is taken from the definitions of **autoExport\_<field\_name>**.

If  $n = 2$ , the following variables are requested by default:

*BS 7608 analysis: LL, SMAX, WCM, WCA*

*All other analyses:*

*LL, FRFR, FRFV, FRFH, FRFW, SMAX, WCM, WCA*

If the factor of strength or yield calculations are enabled, the *FOS* and *YIELD* variables are automatically written to the ODB.

Note that output to the ODB file is not supported by the Uniaxial Stress-Life algorithm.

If  $n = 3$ , all available output variables are written to the ODB file.

**autoExport\_<field\_name>**

Controls which fields are written to the Abaqus .odb file if the variable selection type is set to "Select from list below" by **autoExport\_selectionMode**.

*Environment file usage:*

setappdata(0, 'autoExport\_<field\_name >', n);

n has the following definitions:

- 1: Export field <field\_name>
- 0: Do not export field <field\_name>

### 3. Material keywords

#### 3.1 Background

This section describes all of the keywords that are available for defining material text files in Quick Fatigue Tool. Guidance on creating and importing materials from a text file is provided in Section 5.6 “Creating a material from a text file” of the *Quick Fatigue Tool User Guide*.

Material keyword are followed by parameters and/or data lines which complete the keyword definition. The format of the material keyword is as follows:

```
*KEYWORD, parameter  
data line 1  
data line 2  
...  
data line n
```

## 3.2 Material keywords table

The following table provides a description of each material keyword and their associated parameters.

### **\*USER MATERIAL**

Begin the definition of a material.

---

This option is used to indicate the start of a material definition.

#### **Required parameter:**

NAME

Set this parameter to a label that will be used to refer to the material with the job file option MATERIAL.

**There are no data lines associated with this option.**

### **\*DESCRIPTION**

Provide a description of the material.

---

This option is used to provide a summary for the material.

**There are no parameters associated with this option.**

#### **Data line to provide a description:**

##### **First line:**

1. The description.

Repeat this data line as often as necessary to define the material description.

### **\*DEFAULT ALGORITHM**

Specify the default analysis algorithm.

---

This option is used to specify the analysis algorithm which is used when ALGORITHM=default in the job file.

#### **Required, mutually exclusive parameters:**

[UNIAXIAL STRESS | UNIAXIAL STRAIN | SBBM | NORMAL | FINDLEY | INVARIANT | WELD | NASALIFE]

Uniaxial Stress-Life, Uniaxial Strain-Life, Stress-based Brown-Miller, Normal Stress, Findley's Method, Stress Invariant Parameter, BS 7608 and NASALIFE, respectively.

**There are no data lines associated with this option.**

### **\*DEFAULT MSC**

Specify the default mean stress correction.

---

This option is used to specify the mean stress correction which is used when MS CORRECTION=default in the job file.

**Required, mutually exclusive parameters:**

[MORROW | GOODMAN | SODERBERG | WALKER | SWT | GERBER | RATIO | NONE]

**There are no data lines associated with this option.**

### **\*CAEL**

Specify the constant amplitude endurance limit.

---

This option is used to specify the constant amplitude endurance limit of the material. This is the life below which Quick Fatigue Tool assumes the material experiences no fatigue damage.

**There are no parameters associated with this option.**

**Data line to define the constant amplitude endurance limit:**

**First (and only) line:**

1. The constant amplitude endurance limit ( $2N_f$ ).
2. A flag (1 or 0) indicating if this variable is active in the material.

### **\*REGRESSION**

Specify the regression algorithm.

---

This option is used to specify the regression algorithm for undefined material properties.

**Required, mutually exclusive parameters:**

[UNIFORM | UNIVERSAL | MODIFIED | 9050 | NONE]

Uniform Law (Baumel & Seeger), Universal Slopes (Manson), Modified Universal Slopes (Muralidharan), 90/50 Rule, none, respectively.

**There are no data lines associated with this option.**

### **\*MECHANICAL**

Specify mechanical constants.

---

This option is used to define mechanical properties.

**There are no parameters associated with this option.**

**Data lines to define mechanical properties:**

**First line:**

1. Young's Modulus ( $E$ ).
2. Poisson's ratio ( $\nu$ ).
3. Ultimate tensile strength ( $\sigma_U$ ).
4. Yield (proof) stress ( $\sigma_Y$ ).

**Second (optional) line:**

1. A flag (1 or 0) indicating if  $E$  is active in the material.
2. A flag (1 or 0) indicating if  $\nu$  is active in the material.
3. A flag (1 or 0) indicating if  $\sigma_U$  is active in the material.
4. A flag (1 or 0) indicating if  $\sigma_Y$  is active in the material.

## **\*FATIGUE**

Specify fatigue properties.

---

This option is used to define fatigue properties. Fatigue properties can be supplied as constants for the stress-life and strain-life equations, and/or as test data defining the stress-life curve.

### **Required, mutually exclusive parameters:**

[CONSTANTS | TEST DATA]

### **Data lines to define fatigue properties (CONSTANTS):**

#### **First line:**

1. Fatigue strength coefficient ( $\sigma_f'$ ).
2. Fatigue strength exponent ( $b$ ).
3. Fatigue ductility coefficient ( $\epsilon_f'$ ).
4. Fatigue ductility exponent ( $c$ ).

#### **Second (optional) line:**

1. A flag (1 or 0) indicating if  $\sigma_f'$  is active in the material.
2. A flag (1 or 0) indicating if  $b$  is active in the material.
3. A flag (1 or 0) indicating if  $\epsilon_f'$  is active in the material.
4. A flag (1 or 0) indicating if  $c$  is active in the material.

### **Data lines to define fatigue properties (TEST DATA):**

#### **First line:**

1. First N-value.
2. Corresponding S-value for the first load ratio.
3. Corresponding S-value for the second load ratio.

Continue this data line until the S-values are provided for all load ratios.

#### **Second line:**

1. Second N-value.
2. Corresponding S-value for the first load ratio.
3. Corresponding S-value for the second load ratio.

Repeat this data line as often as necessary to define all N-values. A minimum of two N-values is required.



### **\*R RATIOS**

Specify load ratios for S-N data.

---

This option is used to define a list of load ratios. It is only required if the **TEST DATA** parameter is used with **\*FATIGUE** and more than one S-value is provided for each N-value.

**There are no parameters associated with this option.**

**Data line to define load ratios:**

**First (and only) line:**

1. First load ratio.

Continue this data line until the load ratios are provided for all S-N curves.

### **\*CYCLIC**

Specify cyclic properties.

---

This option is used to define cyclic hardening properties. These properties are required for the following features in Quick Fatigue Tool:

- plasticity correction;
- yield calculation; and
- damage calculation for Multiaxial Gauge Fatigue analysis.

**There are no parameters associated with this option.**

**Data lines to define cyclic properties:**

**First line:**

1. Cyclic strain hardening coefficient ( $K'$ ).
2. Cyclic strain hardening exponent ( $n'$ ).

**Second (optional) line:**

1. A flag (1 or 0) indicating if  $K'$  is active in the material.
2. A flag (1 or 0) indicating if  $n'$  is active in the material.

### **\*NORMAL STRESS SENSITIVITY**

Specify the normal stress sensitivity constant for Findley's Method.

---

This option is used to define the normal stress sensitivity constant,  $k$ , if ALGORITHM=findley in the job file.

#### **Required, mutually exclusive parameters:**

[USER | SOCIE | GENERAL | DANGVAN | SINES | CROSSLAND]

#### **Data line to specify a user-defined value of $k$ (USER):**

##### **First (and only) line:**

1. Normal stress sensitivity constant ( $k$ ).

#### **Data line to define $k$ based on the general formula (GENERAL):**

##### **First (and only) line:**

1. Reference load ratio ( $R_i$ ).
2. Tensile fatigue limit at  $R_i$ .
3. Torsional fatigue limit at  $R = -1$ .

#### **Data line to define $k$ based on the Dang Van formula (DANGVAN):**

##### **First (and only) line:**

1. Tensile fatigue limit at  $R = -1$ .
2. Torsional fatigue limit at  $R = -1$ .

#### **Data line to define $k$ based on the Sines formula (SINES):**

##### **First (and only) line:**

1. Tensile fatigue limit at  $R = -1$ .
2. Torsional fatigue limit at  $R = -1$ .
3. Ultimate tensile strength.

#### **Data line to define $k$ based on the Crossland formula (CROSSLAND):**

##### **First (and only) line:**

1. Tensile fatigue limit at  $R = -1$ .
2. Torsional fatigue limit at  $R = -1$ .

### **\*CLASS**

Specify the material class.

---

This option is used to specify the material class.

If ALGORITHM=findley in the job file, the material class is used along with the normal stress sensitivity constant,  $k$ , to determine the value of the modified fatigue shear strength coefficient,  $\tau_f^*$ .

If ndEndurance = 0 in the environment file, the material class is used to determine whether damage is calculated below the material's endurance limit.

**Required, mutually exclusive parameters:**

[WROUGHT STEEL | DUCTILE IRON | MALLEABLE IRON | WROUGHT IRON | CAST IRON | ALUMINIUM | OTHER]

**There are no data lines associated with this option.**

### **\*END MATERIAL**

End the definition of a material.

---

This option is used to indicate the end of a material definition.

**There are no parameters or data lines associated with this option.**