Appendix D – Calculation Steps

1. Upon completion of the cyclic test, the displacement and load values are inserted into columns “A” and “B” of file “linearapprox”. The Test ID and bolt diameter values at the top of this file are changed.

2. For each CUREE Protocol that is run, the protocol data in columns “G” through “K” need to be changed. The protocol data reports the approximate data point where the cycle changes direction.

3. Run macro’s “Calc. Set 1” and “Calc. Set 2”

4. The load-displacement curve and the linear piece-wise approximation are plotted. Columns “AL” and “AM” are the displacement and load values for the positive portion of the linear piece-wise approximation. Columns “AO” and “AP” are the displacement and load values for the negative portion of the linear piece-wise approximation. The positive values are copied and pasted into “M30” and “N30” of file “posana”. The negavtive values are copied and pasted into “R5” and “S5” of file “negana”.

5. In the “posana” file the lower and upper ranges found in column “L” are set to cover the initial linear portion of the data. The bolt diameter value is inputted. Next the “analyze” macro is run.

6. Output from the macro is automatically inserted into column “P”. The 5% offset yield and displacement are manually changed to correspond to the point where the 5% offset line interests the load-displacement curve. The failure load is manually changed to be (0.8*max load) and the disp. at failure is also manually changed. Columns M and N are examined between rows 30 to 37. The points of the load-displacement curve between which the failure load occurs is identified. The displacement at failure is linearly interpreted from these data points.

7. The data in “P3” through “P23” in file “posana” is the final positive results.

8. In the file “linearapprox”, the three data points comprising the positive portion of the equivalent elastic-plastic curve need to be inserted in cells T70 through U72. Using data from the “posana” file, the first point has an x value corresponding to cell “P20” and a y value of 0. The second point has a x value corresponding to cell “P13” and a y value corresponding to cell “P12”. The third point has a x value corresponding to cell “P7” and a y value corresponding to cell “P12”.

9. In the “negana” file the lower and upper ranges found in column “L” are set to cover the initial linear portion of the data. The bolt diameter value is inputted. Next the “analyze” macro is run.

10. Output from the macro is inserted into column “P”. The 5% offset yield and displacement are manually inserted to correspond to the point where the 5% offset line interests the load-displacement curve. The failure load is manually changed to be (0.8*max load) and the disp. at failure is also manually changed. Columns M and N are examined between rows 30 to 36. The points of the load-displacement curve between which the failure load occurs is identified. The displacement at failure is linearly interpreted from these data points.

11. Make all values opposite sign and the data in “P3” through “P23” in file “negana” is the final negative results.

12. In the file “linearapprox”, the three data points comprising the negative portion of the equivalent elastic-plastic curve need to be inserted in cells Q70 through R72. Using data from the “negana” file, the first point has an x value corresponding to cell “P20” and a y value of 0. The second point has a x value corresponding to cell “P13” and a y value corresponding to cell “P12”. The third point has a x value corresponding to cell “P7” and a y value corresponding to cell “P12”.