ASME STANDARDS TECHNOLOGY, LLC

STP-PT-082

STRESS INTENSITY K FACTORS FOR EXTERNAL SURFACE CRACKS IN THICK-WALLED CYLINDER VESSELS

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STRESS INTENSITY K FACTORS FOR EXTERNAL SURFACE CRACKS IN THICK-WALLED CYLINDER VESSELS

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FOREWORD

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ABSTRACT

This report describes the analysis methods and results for external surface crack stress intensity K solutions in thick-walled cylinders. The 1040 cases include a range of geometry ratios and crack size ratios for external axial and external circumferential surface cracks, axial full-width cracks, and 360° circumferential cracks. These K solutions extend the K factor solutions available in the 2007 API 579-1/ASME FFS-1 Annex C tables. The results are reported as non-dimensional geometry factors that are tabulated in the appendices along with plots of all the result cases.

1 INTRODUCTION

ASME ST-LLC's request-for-proposal RFP-16-03 (project STIN-0151) sought the calculation of stress intensity K factors for external surface cracks in thick-walled cylinder vessels. The 1040 crack analysis cases for this project extend the K factor solutions available in the API 579-1/ASME FFS-1 [1] Annex C tables. This project supplements the results from ASME ST-LLC's project STIN-0130 for the internal crack solutions as identified in ASME ST-LLC's publication STP-PT-072 [2].

The analysis method uses our FEACrack™ [3] software to generate the three-dimensional ("3D") crack meshes, described below. Quest Integrity developed the FEACrack™ software, a commercial product for 3D crack mesh generation and analysis, and has continuously verified its robustness and suitability for analyses such as in the current work. This software was originally released in 1998, and was used to create most of the K factor solutions in Annex C of API 579 [1][4][5]. FEACrack™ creates complete and ready-to-run Abaqus™ [6] input files, including the syntax to define the J-integral calculation, to allow efficient analysis of many crack cases.

The finite element analysis cases are run for each crack mesh using the Abaqus™ solver. Abaqus™ also provides the crack front J-integral calculation at the crack front nodes. FEACrack™ provides automated post processing to help inspect the mesh and crack front J-integral results and tabulate the stress intensity solution factors. FEACrack™ automatically computes the stress intensity K factor from the J-integral using the elastic material properties, and examines the J-integral path dependence to indicate any issues with a result.

The stress intensity results are reported as non-dimensional geometry G factor values, described in Section 1.2. The result values are tabulated in the appendices. Plots of the results for all the cases examined and for result trends are also shown in the appendices. Each appendix begins with a description of the values or plots within the particular appendix.

1.1 Analysis Cases

The crack analysis cases described in the ASME ST-LLC scope of work use the geometry ratio Y = OD/ID and the a/l crack aspect ratio, where OD is the cylinder outside diameter, ID is the cylinder inside diameter, a is the crack depth, and l is the total semi-elliptical crack length. The crack depth ratio a/t describes the crack depths examined, where t is the cylinder wall thickness.

The Y and a/l ratios are related to the t/Ri and a/c ratios used in the API 579 Annex C tables, where Ri is the cylinder inside radius and c is the half semi-elliptical surface crack length: t/Ri = Y-1, a/l = (a/c)/2, 2c = l. The same a/l and a/t ratio values as the Annex C solutions were used so that the new stress intensity solutions can be easily added to the existing solution tables. Both sets of ratios are given in Table 1 through Table 3 below. The Y = 2 ratio (t/Ri = 1) overlaps the current solutions so that the new results can be compared to show continuity of values. The new solutions extend the Y ratio to 4 (t/Ri = 3) for the thickest cylinder case examined.

Generic values for geometry and loads are used to create the crack meshes, since the final results are given as the non-dimensional geometry G factors.

Table 1: Y and t/Ri Ratios to Set the Cylinder Thickness, t

Case	Y=OD/ID	t/Ri
1	2	1
2	2.5	1.5
3	3	2
4	3.5	2.5
5	4	3

Table 2: a/l and a/c Ratios to Set the Crack Length, l=2c

Case	a/l=a/2c	a/c
1	0.01563	0.03125
2	0.03125	0.0625
3	0.0625	0.125
4	0.125	0.25
5	0.25	0.5
6	0.5	1
7	1	2
8	360-deg or full width	

Table 3: a/t Ratios to Set the Crack Depth, a

Case	a/t
1	0.2
2	0.4
3	0.6
4	0.8

Some of the a/l crack length ratios give circumferential crack lengths that are longer than the thick-walled cylinder outside circumference, so those cases are omitted. Table 4 summarizes the valid circumferential surface crack cases, including the 360-degree crack cases that provide a bounding case for the circumferential crack solutions.

Table 4: External Circumferential Crack Valid Cases

Y=OD/ID =	2							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	ok	ok	ok	ok	ok	ok
0.4	ok	too long	too long	ok	ok	ok	ok	ok
0.6	ok	too long	too long	ok	ok	ok	ok	ok
0.8	ok	too long	too long	too long	ok	ok	ok	ok
Y=OD/ID =	2.5							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	ok	ok	ok	ok	ok	ok
0.4	ok	too long	too long	ok	ok	ok	ok	ok
0.6	ok	too long	too long	ok	ok	ok	ok	ok
0.8	ok	too long	too long	too long	ok	ok	ok	ok
Y=OD/ID =	3							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	ok	ok	ok	ok	ok	ok
0.4	ok	too long	too long	ok	ok	ok	ok	ok
0.6	ok	too long	too long	too long	ok	ok	ok	ok
0.8	ok	too long	too long	too long	ok	ok	ok	ok
Y=OD/ID =	3.5							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	ok	ok	ok	ok	ok	ok
0.4	ok	too long	too long	ok	ok	ok	ok	ok
0.6	ok	too long	too long	too long	ok	ok	ok	ok
0.8	ok	too long	too long	too long	ok	ok	ok	ok
Y=OD/ID =	4							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	ok	ok	ok	ok	ok	ok
0.4	ok	too long	too long	ok	ok	ok	ok	ok
0.6	ok	too long	too long	too long	ok	ok	ok	ok
0.8	ok	too long	too long	too long	ok	ok	ok	ok

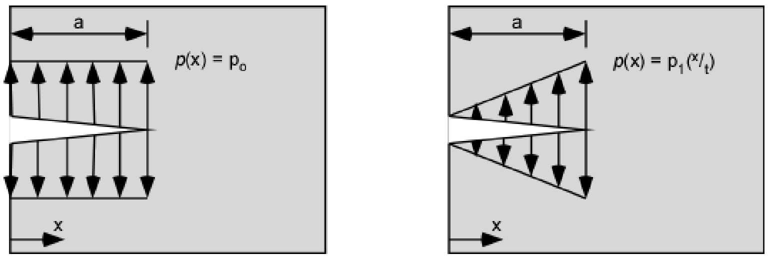
1.2 Geometry Factors

The stress intensity K factors are given in the API 579 [1] Annex C tables as non-dimensional geometry factors: G_0 and G_1 for the surface cracks, where G_0 is the uniform crack face pressure solution and G_1 is the linear crack face pressure solution. Geometry factors G_0 through G_4 are given for the axial full-width and circumferential 360-degree partial-depth cracks. Uniform and linear crack face pressure distributions are applied to the surface crack meshes to obtain the geometry factors for these two load cases. The full-width and 360-degree cracks have uniform, linear, quadratic, cubic, and quartic (fourth order) crack face pressure distributions applied to obtain their geometry factor solutions.

Diagrams of the uniform and linear crack face pressure distributions are shown in Figure 1-1 [7], and the general form of the stress intensity K equations with the geometry factor G are shown below each diagram. The linear crack face pressure is zero at the free surface and increases toward the crack depth. Likewise, the quadratic, cubic, and quartic crack face pressures increase from zero at the free surface to maximum at the crack depth.

Figure 1-1: Crack Face Pressure Distributions

Uniform Crack Face Pressure Linear Crack Face Pressure



$$K_I = p_o G_o \sqrt{\frac{\pi a}{Q}} \quad (1)$$

$$K_I = p_1 G_1 \sqrt{\frac{\pi a}{Q}} \quad (2)$$

The circumferential surface cracks also have two global bending K solutions in API 579 [1] Table C.13 that provide the G_5 (in-plane bending) and G_6 (out-of-plane bending) geometry factor solutions. Since the bending load cases can put part of the surface crack into compression and would cause crack face closure, superposition is used to apply a combined bending plus axial load, so that the entire crack front is in tension for the finite element analysis solution. Then, subtracting the axial load solution from the combined load solution obtains the bending only solution for each case, which may be negative due to compressive stress. To keep the crack front in tension the axial load is six times the bending load to avoid crack closure in some of the larger crack size cases.

For example, the entire crack front is put into tension by applying a combined axial force and bending moment, which gives the total crack front stress intensity K_{total}. The axial force is applied by itself in another model to get the crack front stress intensity K_{axial}. The principle of superposition allows combining load cases in linear elastic analysis such that: $K_{total} = K_{bending} + K_{axial}$. The bending only stress intensity is obtained by subtracting the axial load case from the combined load case: $K_{bending} = K_{total} - K_{axial}$. The bending only K solutions can be negative so that when combined with other load cases in a crack assessment the correct sum of the K solutions from each loading component is obtained. In a crack assessment, a total negative K value after combining all loads indicates crack closure and K is set to zero.

The FEACrack™ post processor computes the crack front stress intensity K solutions from the Abaqus™ J-integral results and uses the applied loading to compute the non-dimensional geometry G factors. A sixth order polynomial is used to curve-fit the G solution along the crack front. The seven polynomial coefficients are tabulated for each crack case to give the same result format as in the API 579 [1] Annex C tables. The geometry factor polynomial, G, is given by the equations below [1] (equations C.91 and C.96).

$$G = A_0 + A_1\beta + A_2\beta^2 + A_3\beta^3 + A_4\beta^4 + A_5\beta^5 + A_6\beta^6 \quad (3)$$

$$\beta = \frac{2\varphi}{\pi} \quad (4)$$

where the crack front position angle, φ, varies from 0 at the crack tip (at the free surface) to $\pi/2$ at the deepest point of the surface crack. Likewise, the non-dimensional crack front position, β, varies from 0 at the crack tip to 1 at the crack depth. The polynomial curve fit coefficient values are given by the A_0 through A_6 values. The geometry factor and stress intensity solutions at the crack tip location are obtained by setting $\beta = 0$, which gives just the A_0 coefficient. The geometry factor and stress intensity solutions at the crack depth location are given by setting $\beta = 1$, which is the sum of the A_i coefficient values: $G(\beta=1) = \Sigma A_i$, i=0,6. By reporting the polynomial coefficients, A_0 through A_6, the stress intensity solution is available along the entire crack front in addition to the crack tip and crack depth locations.

The axial full-width and circumferential 360° partial-depth cracks have a constant stress intensity value along the crack front, so only the A_0 coefficient is reported for the geometry factors for each crack face pressure load case.

The non-dimensional geometry factor solutions obtained for the uniform and linear surface crack face pressure load cases can be used to infer the solutions for other loading distributions by using the weight function method as described in the API 579 [1] Section C.14. The weight function method uses equations and weighting factors to combine the G_0 and G_1 solutions to obtain other load case solutions. For example, the non-uniform stress distribution due to internal pressure in a thick-walled cylinder could be used to obtain the corresponding G solution using the weight function method.

2 AXIAL EXTERNAL SURFACE CRACKS

The combination of geometry ratios and two load cases gives 280 axial external surface crack meshes. The model "Run ID" numbers are used to uniquely identify each case, from 1 through 280. The non-dimensional G polynomial coefficient results are listed in Table 5 in Appendix A and in the corresponding Excel file delivered with this report.

The axial external surface crack meshes are quarter symmetric models; the constraints and dimensions are shown in Figure 2-1. The left end of the cylinder is the cross-section symmetry plane and has an X-constraint. The top and bottom mesh surfaces are on the axial symmetry plane and have a Z-constraint outside the crack. The right end of the cylinder is unconstrained. A single node at the top of the cylinder has a Y-constraint. The green mesh zone is used to improve the mesh refinement near the crack plane, and has the same elastic material properties as the red mesh zone in the cylinder model. The crack face pressure loading is applied to the crack face elements in the light blue mesh region.

For the shallower crack depths, more elements are added through the thickness in the ligament outside the crack as shown in Figure 2-2. An example of the thickest cylinder, Y = 4 (t/Ri = 3) is shown in Figure 2-3.

Figure 2-1: Quarter Symmetric Crack Mesh, case 149, t/Ri=2, a/c=0.5, a/t=0.6

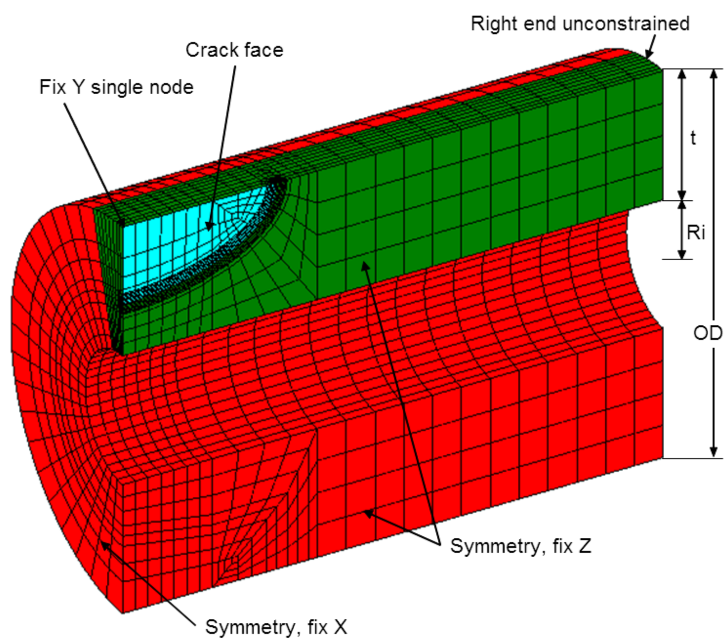


Figure 2-2: Shallow Crack Mesh example, case 17, t/Ri=1, a/c=0.125, a/t=0.2

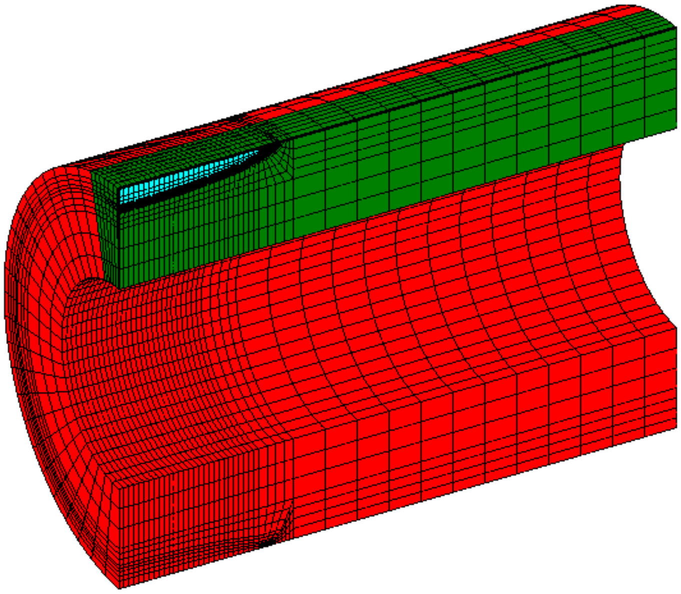
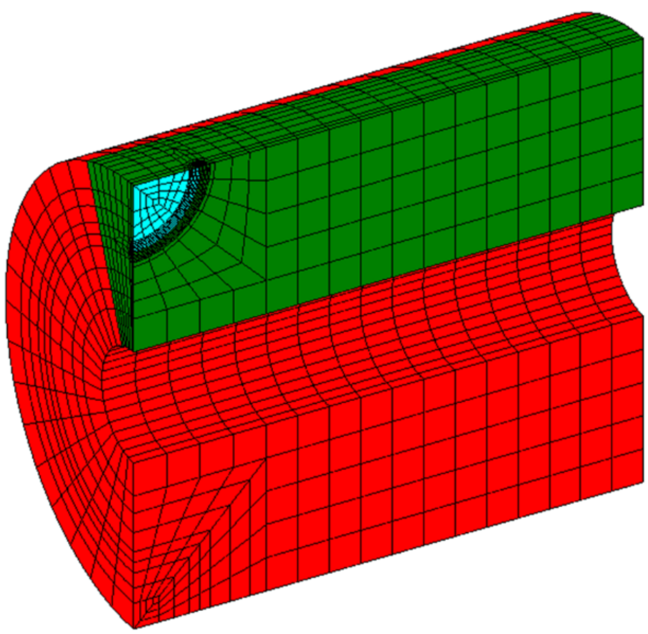


Figure 2-3: Thickest Cylinder Example, case 267, t/Ri=3, a/c=1.0, a/t=0.4



3 AXIAL EXTERNAL FULL-WIDTH CRACKS

The combination of geometry ratios and five load cases gives 100 axial external full-width crack meshes. The full-width crack meshes are intended to model an infinitely long, partial-depth crack as a bounding solution for long axial surface cracks. The model "Run ID" numbers are used to uniquely identify each case, from 281 through 380. The non-dimensional G polynomial coefficient results are listed in Appendix B, Table 6 and in the corresponding Excel file delivered with this report.

The axial full-width crack meshes are quarter symmetric models; the constraints and dimensions are shown in Figure 3-1. The left end of the cylinder is the cross-section symmetry plane and has an X-constraint. The top and bottom mesh surfaces are on the axial symmetry plane and have a Z-constraint outside the crack. The right end of the cylinder is constrained in the X-direction to model the infinitely long partial-depth crack. A single node at the top of the cylinder has a Y-constraint. The green mesh zone is used to improve the mesh refinement near the crack plane, and has the same elastic material properties as the red mesh zone in the cylinder model. The crack face pressure loading is applied to the crack face elements in the light blue mesh region. The full-width crack mesh does not need to be very long, since the geometry factor is constant along the crack front for the infinitely long crack being modeled.

An example of the deepest full-width crack in the thickest cylinder is shown in Figure 3-2.

Figure 3-1: External Full-Width Crack, case 281, t/Ri=1, a/t=0.2

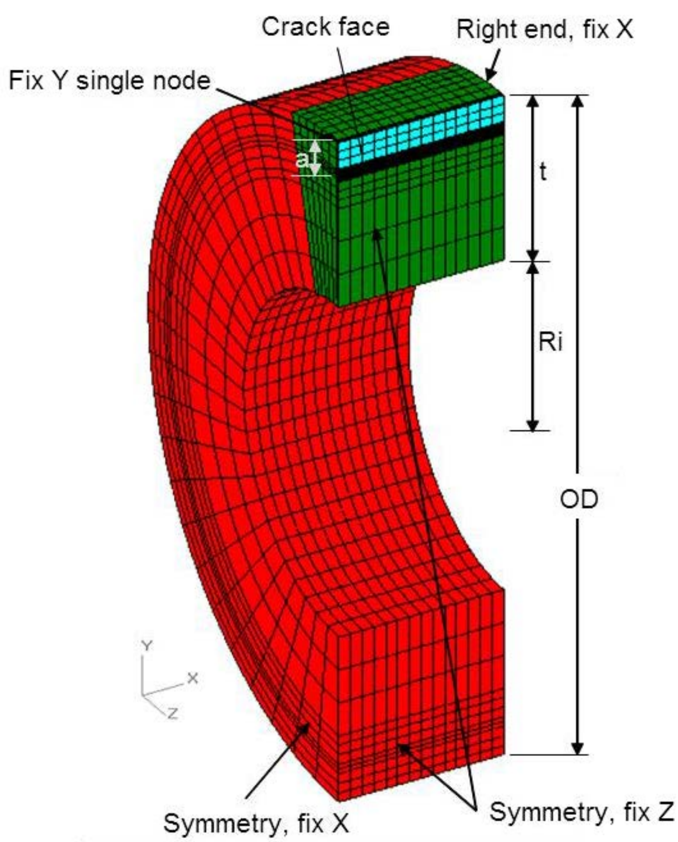
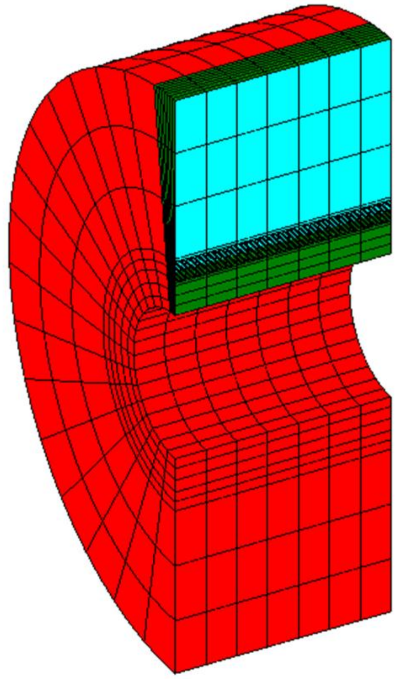


Figure 3-2: Thickest Cylinder, Full-Width Crack, case 377, t/Ri=3, a/t=0.8

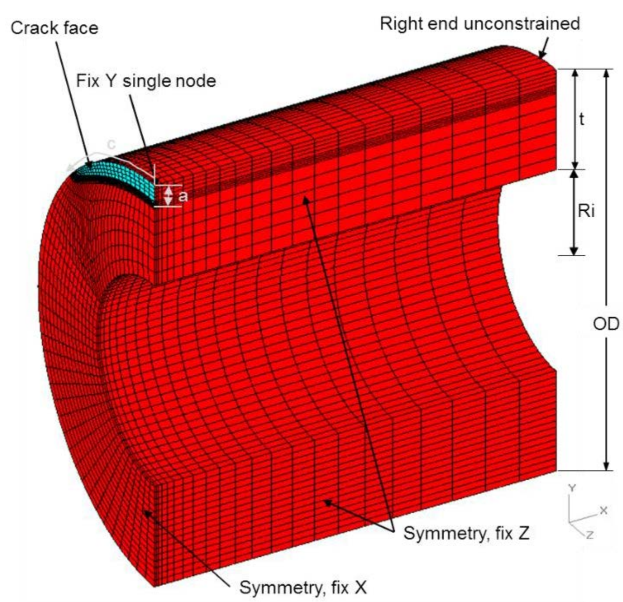


4 CIRCUMFERENTIAL EXTERNAL SURFACE CRACKS

The combination of geometry ratios and four load cases gives 388 external circumferential surface crack meshes. The model "Run ID" numbers are used to uniquely identify each case, from 381 through 940, with gaps for cases where the crack length is too long for the inside cylinder circumference (see Table 4). The non-dimensional G polynomial coefficient results are listed in Appendix C, Table 7 and in the corresponding Excel file delivered with this report.

The circumferential surface crack meshes are quarter symmetric models for linear crack face pressure and in-plane bending load cases. Half symmetric models are needed for uniform crack face pressure and out-of-plane bending load cases. The quarter symmetric model constraints and dimensions are shown in Figure 4-1. The left end of the cylinder is the cross-section symmetry plane and has an X-constraint on the nodes outside the crack. The top and bottom mesh surfaces are on the axial symmetry plane and have a Z-constraint. The right end of the cylinder is unconstrained for the crack face pressure load cases. The bending load cases are shown below. A single node at the top of the cylinder has a Y-constraint. The crack face pressure loading is applied to the crack face elements in the light blue mesh region.

Figure 4-1: External Circumferential Surface Crack, case 414, t/Ri=1, a/c=0.125, a/t=0.2



A deeper and longer circumferential crack is shown in Figure 4-2. A circumferential crack in the thickest cylinder is shown in Figure 4-3, and the same size cylinder and same size crack for the half-symmetric mesh for the uniform crack face pressure and out-of-plane bending load cases is shown in Figure 4-4.

The combined loading for the in-plane bending about the z-axis plus the axial load in the x-direction is shown in Figure 4-5. The combined loading for the out-of-plane bending about the y-axis plus the axial load in the x-direction is shown in Figure 4-6 for the half symmetric mesh.

Figure 4-2: Circumferential Surface Crack Case 666, t/Ri=2, a/c=0.25, a/t=0.8

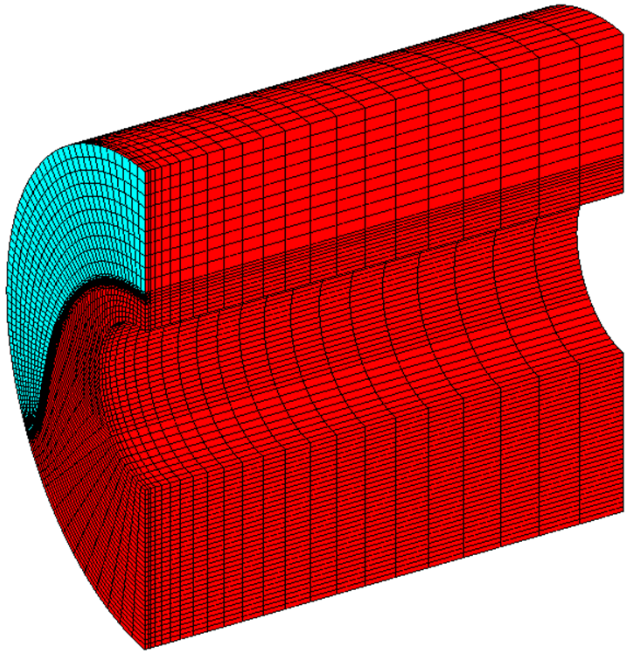


Figure 4-3: Circumferential Surface Crack Case 866, t/Ri=3, a/c=0.125, a/t=0.4, Thickest Cylinder

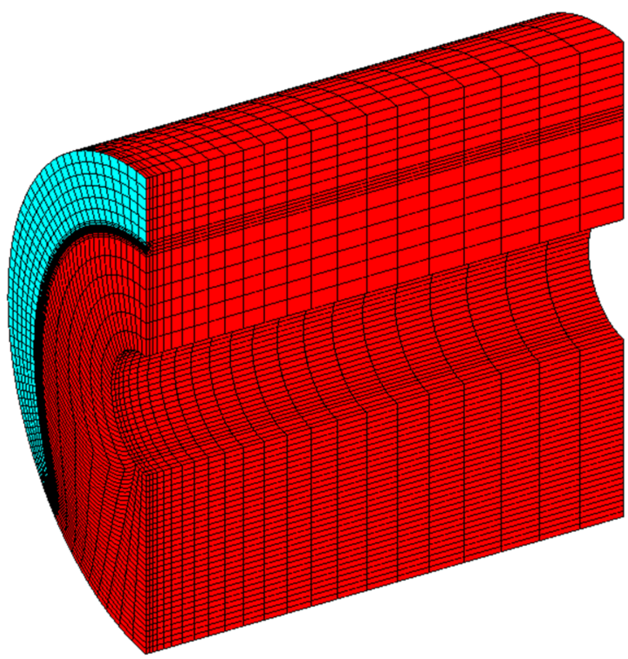


Figure 4-4: Case 868, t/Ri=3, a/c=0.125, a/t=0.4, Half Symmetric Mesh to apply the Out-Of-Plane Bending Load about the y-Axis

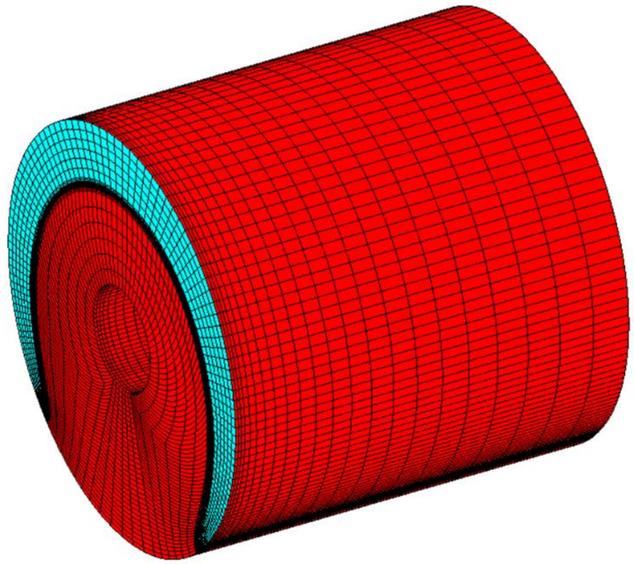


Figure 4-5: Combined in-Plane Bending plus Axial Load, case 423, t/Ri=1, a/c=0.125, a/t=0.6

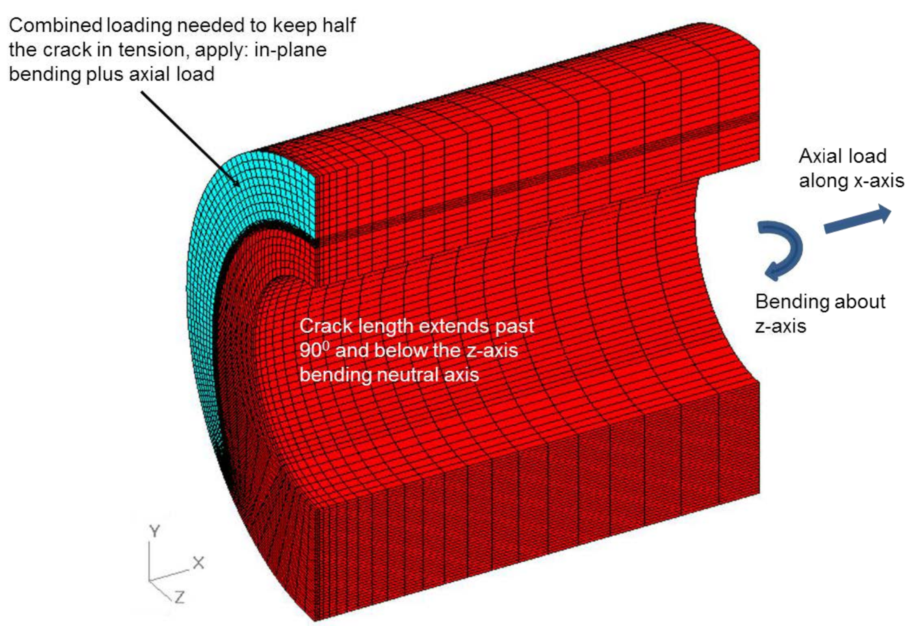
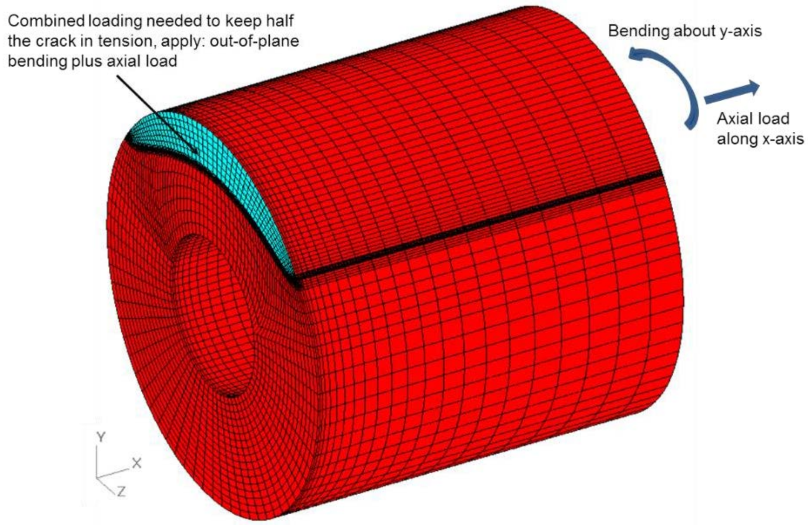


Figure 4-6: Combined Out-of-Plane Bending plus Axial load, Case 548, t/Ri=1.5, a/c=0.25, a/t=0.4



5 CIRCUMFERENTIAL EXTERNAL 360° CRACKS

The combination of geometry ratios and five load cases gives 100 circumferential external 360° crack meshes. The 360° crack meshes are intended to provide a bounding solution for the crack lengths that are longer than the external cylinder circumference. The model "Run ID" numbers are used to uniquely identify each case, from 1100 through 1199. The non-dimensional G polynomial coefficient results are listed in Appendix D, Table 8 and in the corresponding Excel file delivered with this report.

The circumferential external 360° crack meshes are quarter symmetric models; the constraints and dimensions are shown in Figure 5-1. The left end of the cylinder is the cross-section symmetry plane and has an X-constraint on the nodes in the ligament region outside the crack. The top and bottom mesh surfaces are on the axial symmetry plane and have a Z-constraint. The right end of the cylinder is unconstrained. A single node at the top of the cylinder has a Y-constraint. The crack face pressure loading is applied to the crack face elements in the light blue mesh region on the left end of the cylinder.

An example of the shallow crack mesh is shown in Figure 5-2. An example of the thickest cylinder with a deep 360° crack is shown in Figure 5-3.

Figure 5-1: External Circumferential 360° Crack, case 1130, t/Ri=1.5, a/t=0.6

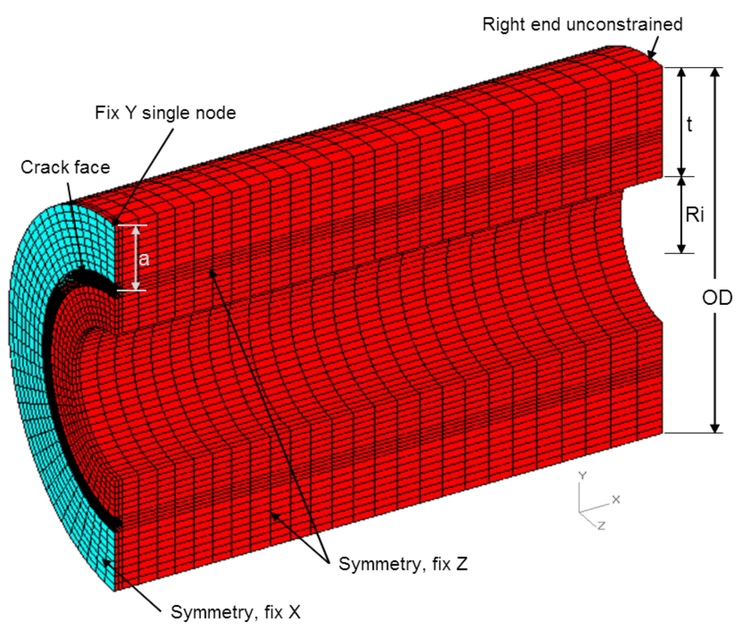


Figure 5-2: 360° Crack, Case 1100, t/Ri=1, a/t=0.2, Shallow Crack example

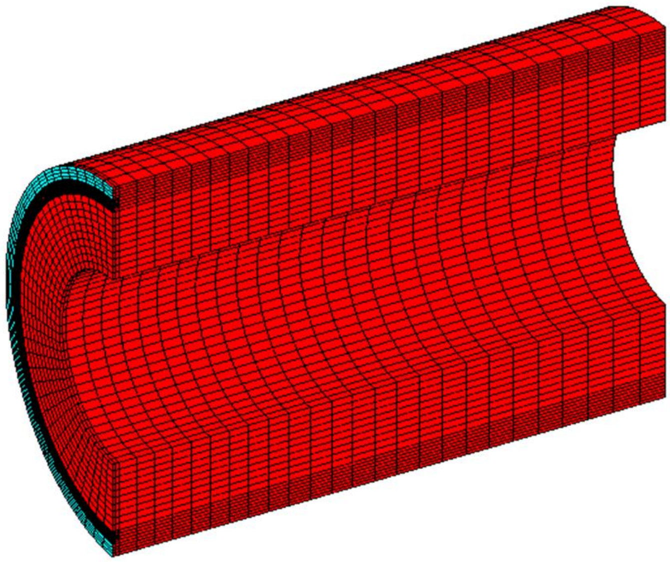
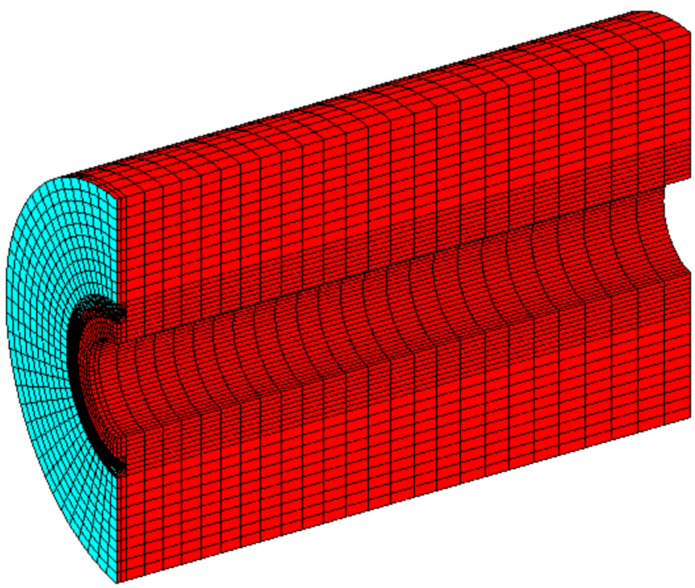


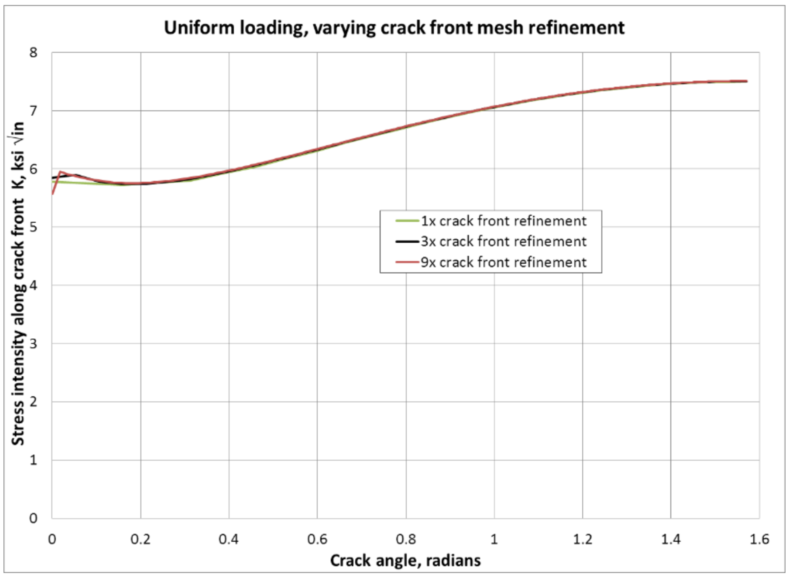
Figure 5-3: 360° Crack, Case 1195, t/Ri=3, a/t=0.8, Thickest Cylinder



6 MESH REFINEMENT STUDY

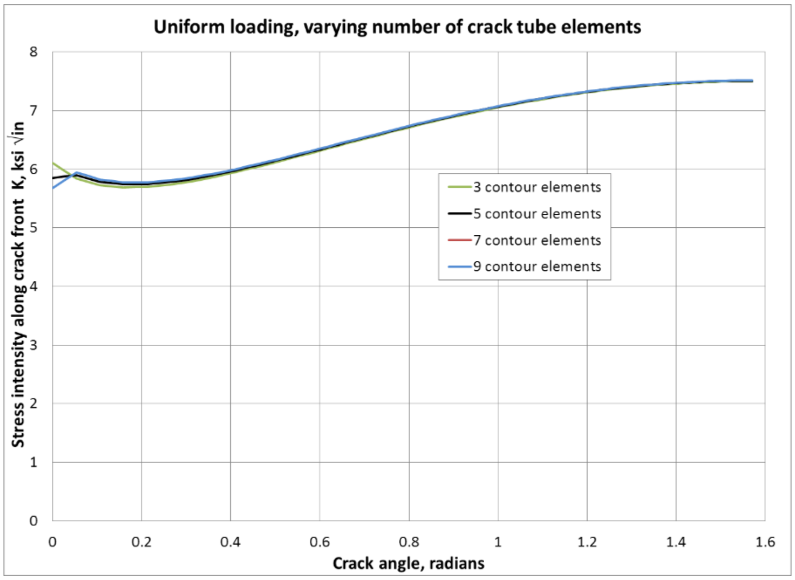
Several aspects of the crack mesh refinement were examined to confirm that sufficient mesh refinement was used for the crack models in this analysis. The number of elements along the crack front was varied from the default 1x crack front refinement to 3x refinement (three times as many crack front elements) and to 9x refinement (nine times as many crack front elements). The plot in Figure 6-1 shows that there is good agreement along most of the crack front, with some difference at the crack tip node. Free surface effects are expected at the crack tip node, so the observed difference in the K solutions results in this comparison is expected. Omitting the crack tip node from the non-dimensional geometry factor results curve-fit is discussed in the Results section below. The 3x crack front refinement level was used for this analysis.

Figure 6-1: Compare Crack Front Mesh Refinement for the Uniform Loading Case



The number of elements in the contours around the crack front was varied from three to nine. The number of mesh contours sets the number of J-integral contours used to compute J and subsequently K along the crack front. The plot in Figure 6-2 shows overall good agreement, except near the crack tip for the lower refinement with three contours. Five element contours were used in this analysis.

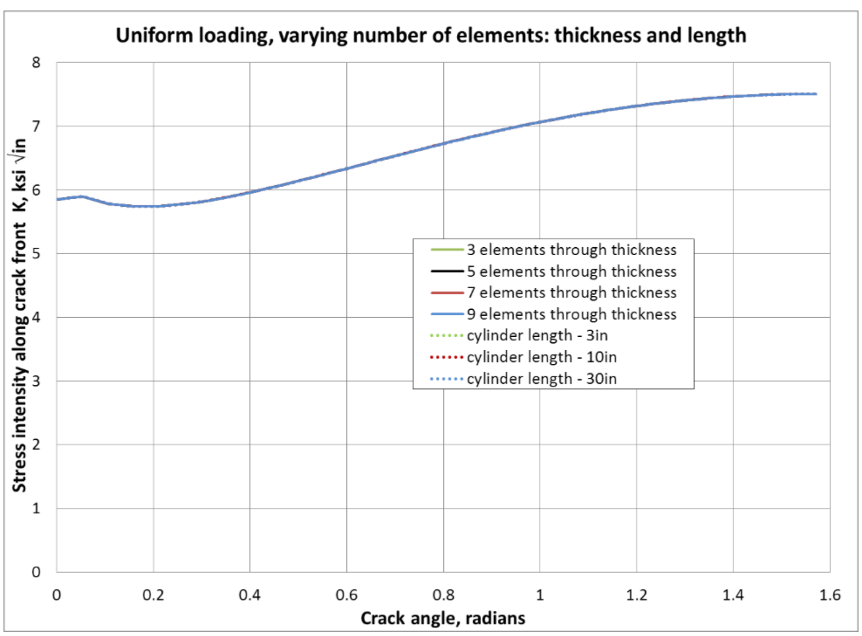
Figure 6-2: Compare the Number of Contours around the Crack Front for the Uniform Loading Case



The number of elements through the remaining ligament in the thickness past the crack depth was varied from three to eight elements. The plot in Figure 6-3 shows no difference in the K results. The number of elements in the ligament for each analysis varies depending on the crack depth.

The additional length of the cylinder past the end of the crack tip was varied from 3 to 30 inches as a multiple of the cylinder OD, and again no difference in the K results was observed. The additional cylinder length past the axial crack length used for this analysis was equal to twice the outside diameter.

Figure 6-3: Compare the Number of Elements through the Thickness and the Cylinder Length for the Uniform Loading Case



The same study was conducted for the linear crack face pressure load case. No difference in the K results were observed from the plots in Figure 6-4 through Figure 6-6, indicating that sufficient mesh refinement is available to compute accurate crack front J values.

Figure 6-4: Compare Crack Front Mesh Refinement for the Linear Crack Face Pressure Load Case

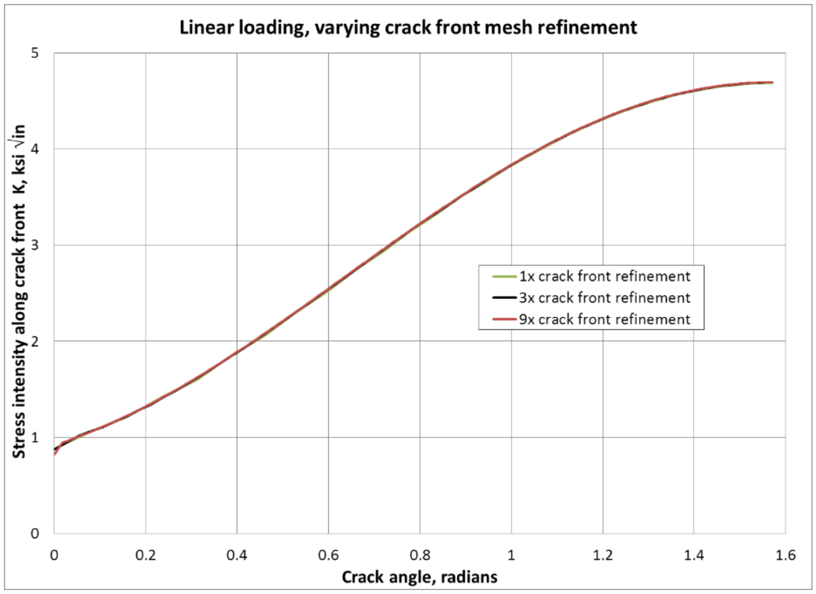


Figure 6-5: Compare the number of Contours around the Crack Front for the Linear Crack Face Pressure Load Case

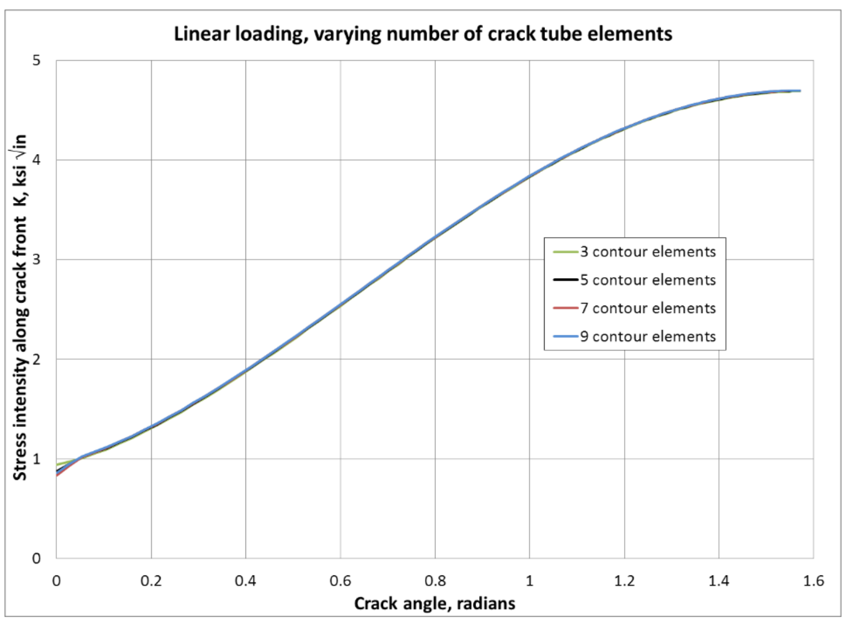
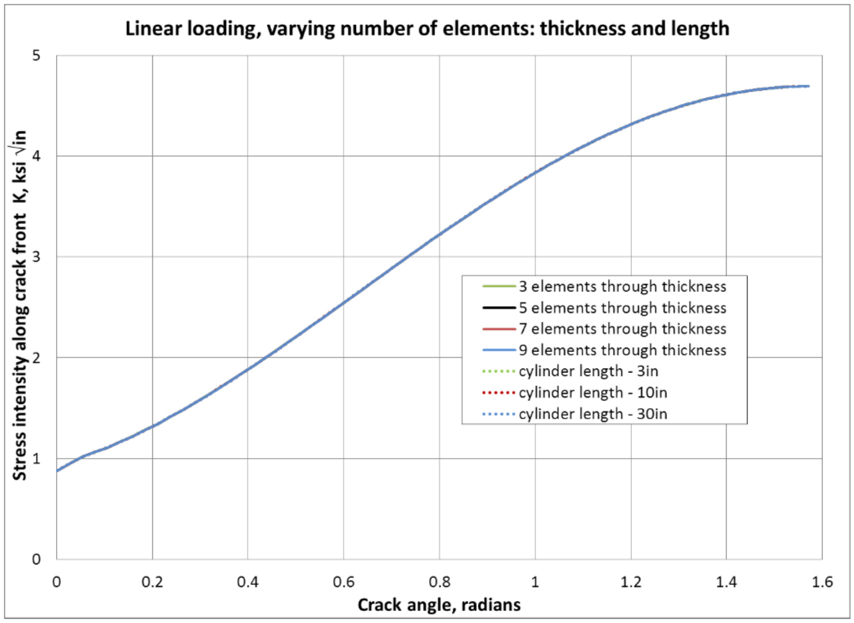


Figure 6-6: Compare the Number of Elements through the Thickness and the Cylinder Length for the Linear Crack Face Pressure Load Case



7 RESULTS AND DISCUSSION

The crack front stress intensity results are reported as a sixth order polynomial curve-fit to the non-dimensional G trend along the crack front for the external surface cracks. The axial full-width and circumferential 360° cracks have a constant G value along the crack front, so a single value is reported. The results values are tabulated in appendices A through D.

Since the crack tip node (at ϕ=0) J-integral value can be inconsistent due to stress triaxiality at the free surface as compared to the overall crack front trend, the crack tip node is omitted from the polynomial curve-fit. This allows the overall curve-fit along the crack front of the non-dimensional geometry factor to extrapolate the solution to the crack tip location.

An example of the external axial surface crack results plot of the non-dimensional G value versus the normalized crack front angle is shown in Figure 7-1; results from axial surface crack cases 1 to 8 are shown. The plot x-axis uses the normalized crack front angle $2\phi/\pi$ along the crack front from 0 at the crack tip to 1 at the crack depth location. The solid curves are for the uniform crack face pressure G_0 load cases, and the dashed curves are for the linear crack face pressure G_1 load cases.

Examples of the external circumferential surface crack results plots are shown in Figure 7-2 (crack face pressure loads) and Figure 7-3 (bending loads) for cases 429 to 444.

Results plots for all the analysis cases are shown in the appendices.

Figure 7-1: Results Plot Example for the Non-Dimensional G Results versus the Normalized Crack Front Angle for the External Axial Surface Crack

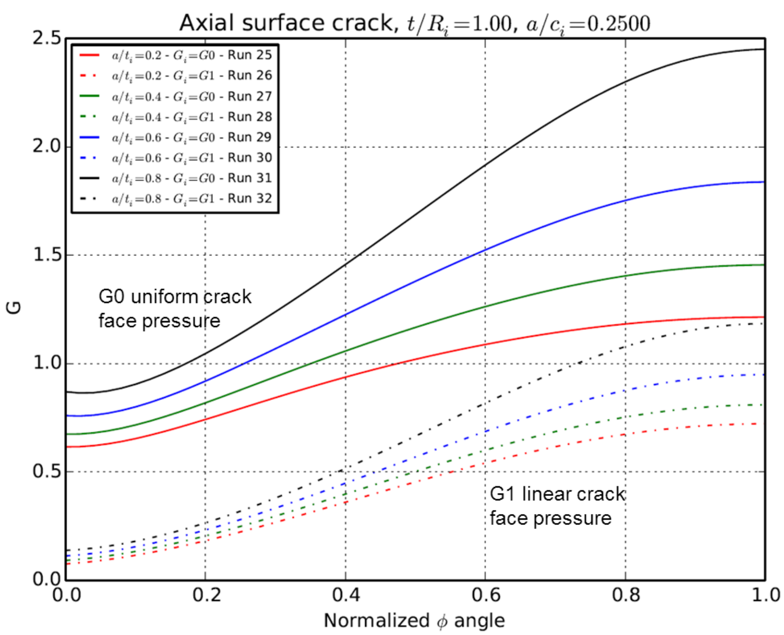


Figure 7-2: Results Plot Example for the External Circumferential Surface Crack, Uniform and Linear Crack Face Pressure Load Cases

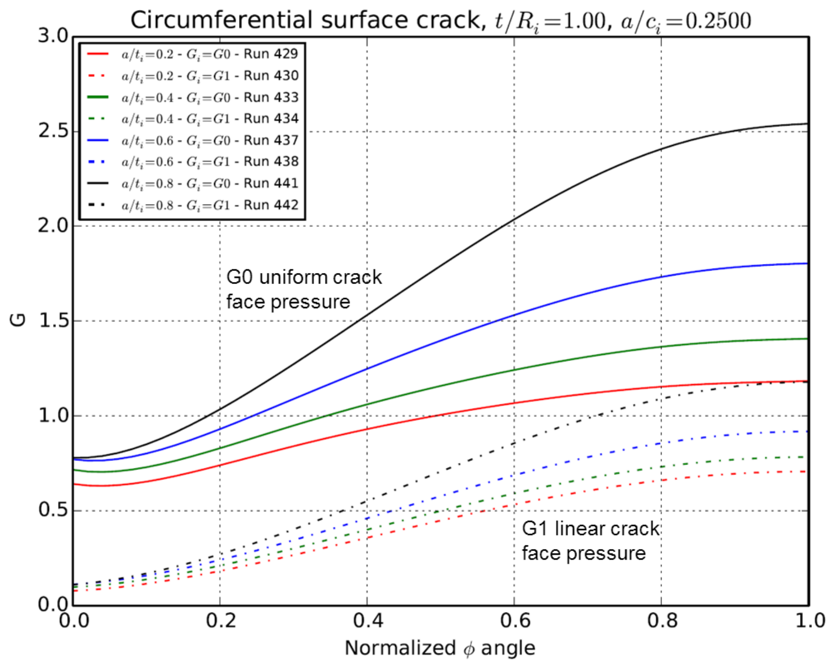
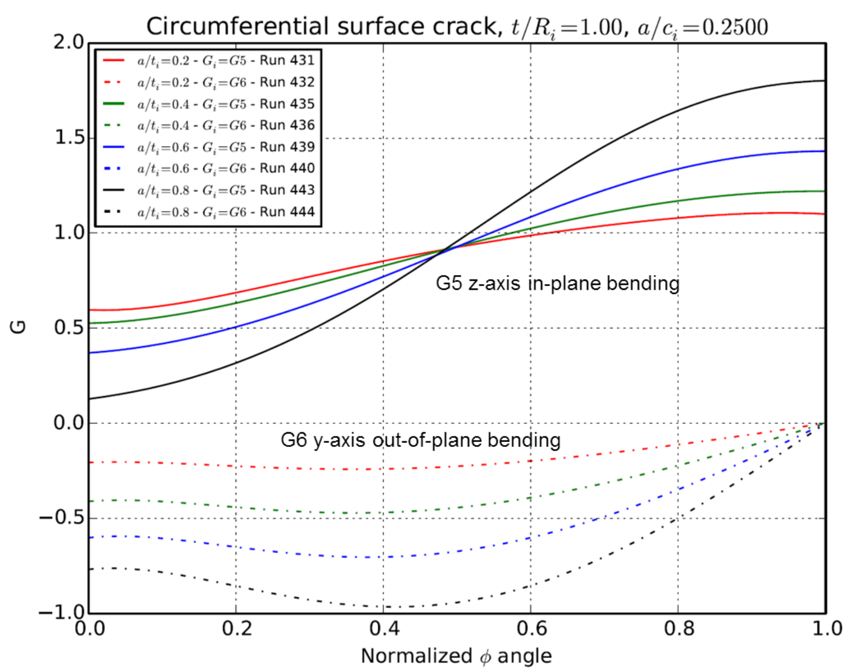


Figure 7-3: Results Plot example for the External Circumferential Surface Crack, In-Plane and Out-of-Plane Bending Load Cases



7.1 Combined Load Post Processing

The non-dimensional geometry G factor solutions for the bending load cases were obtained by subtracting the uniform load results from the combined bending plus axial load results. Subtracting the uniform load result curve from the combined result curve is done by subtracting a set of points along each curve at the same crack front angle locations. Then, a new polynomial curve is fit to the bending only result curve to report the bending only G_5 and G_6 coefficient values.

Figure 7-4 shows an example for the in-plane bending G_5 result. The combined loading is the higher G_{total} values in the plot, and when the uniform G_0 result curve is subtracted, the bending only G_5 result curve is the lower value along the bottom of the plot. Examining the crack mesh deformed shapes showed the possibility of crack face closure for some of the larger crack cases, so a large axial load is needed to avoid crack closure for the combined bending plus axial loading. To keep the crack front in tension the axial load is six times the bending load to prevent crack closure. For a consistent analysis approach, the same axial load was used for all the bending cases. We added an automated post processing check to confirm that there was no crack closure for the combined bending plus axial load results.

Figure 7-5 shows an example for the out-of-plane bending G_6 result. Just half of the crack front is used in the range from $2\phi/\pi=0$ (left crack tip) to $2\phi/\pi=1$ (crack depth) even though the half symmetric model crack front extends to $2\phi/\pi=2$ at the right side crack tip so that the same sixth order polynomial can be used to report the crack front results. The combined loading G results are the higher values, and when the uniform G_0 results are subtracted the out-of-plane bending G_6 results are negative along the first half of the crack front (crack closure on half of the crack) going to zero at the crack depth location, which is on the bending neutral axis for the out-of-plane bending load case. The other half of the crack front trend in the $2\phi/\pi=1$ to $2\phi/\pi=2$ range is anti-symmetric for the out-of-plane bending load case and can be obtained by changing the sign of the G results.

Figure 7-4: Subtract G result Curves to get In-Plane Bending only result: $G_5 = G_{total} - G_0$

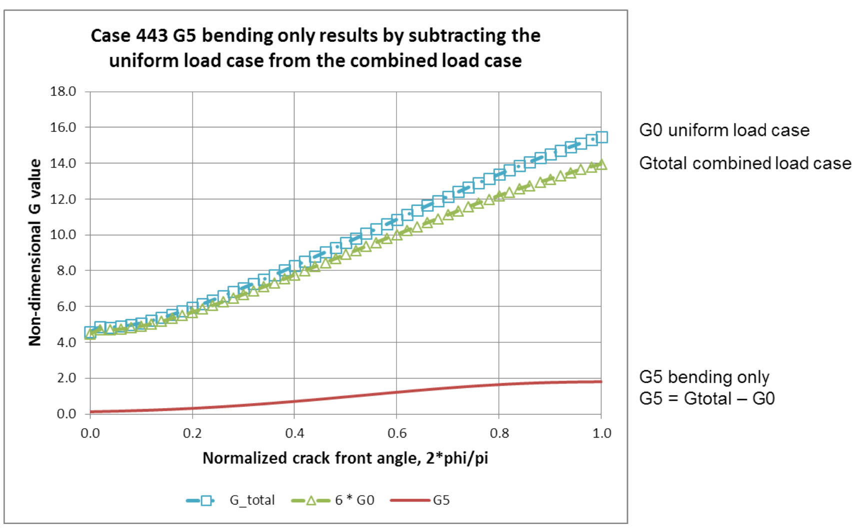
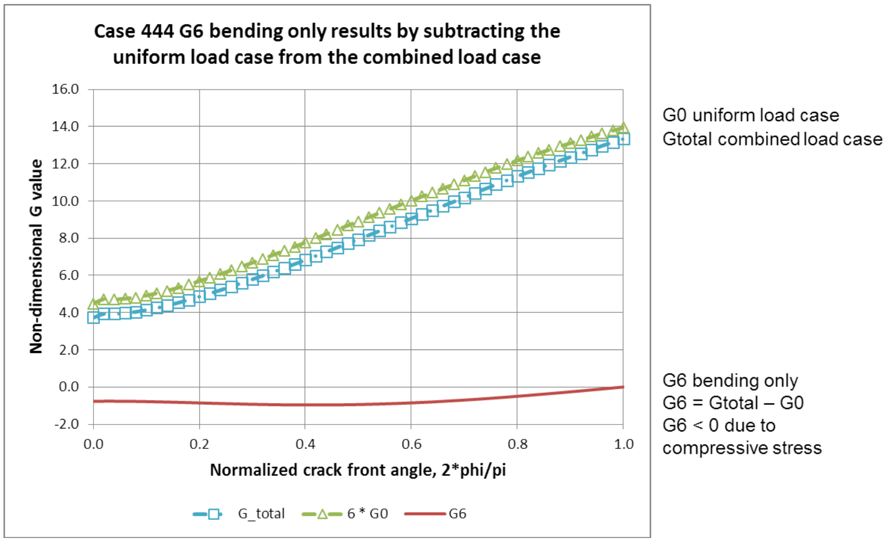


Figure 7-5: Subtract G result Curves to get Out-Of-Plane Bending only result: $G_6 = G_{total} - G_0$



7.2 Examination of Non-intuitive Result Trends

The trend plots for the non-dimensional G results were created to check that the computed results followed expected trends as the cylinder and crack dimensions changed. For a few cases, some result trends were non-intuitive, such as the external circumferential surface cracks for t/Ri = 2, a/c = 0.25, uniform crack face pressure G_0 load case. In Figure 7-6 the a/t = 0.8 deep crack G_0 trend (black curve) crosses the other a/t curves at a/c = 0.25 (a longer crack). The crack tip G_0 result for Run 665 drops below the G_0 results for Run 653, 657, and 661. Further examination of the crack front G results and crack sizes explains this non-intuitive result trend.

Figure 7-6: Examine the a/t = 0.8 G_0 Non-Intuitive result Trend for Run 665

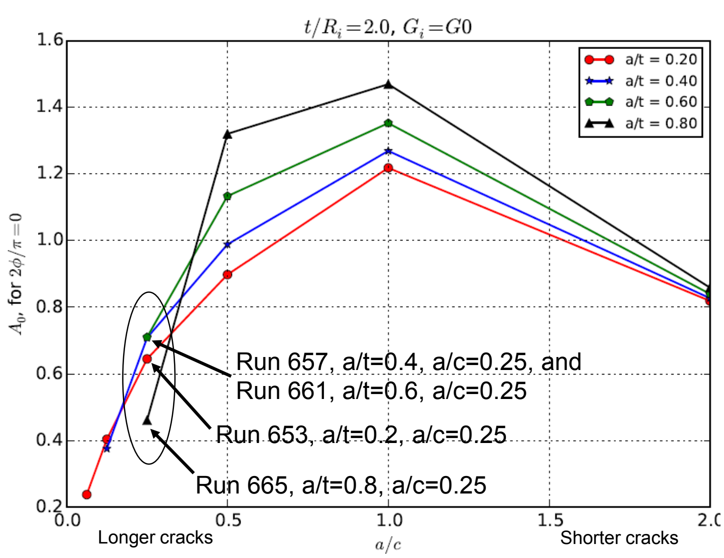


Figure 7-7 shows an end view of the four crack mesh cases identified in Figure 7-6, and shows the relative crack sizes as the crack depth increases. Each surface crack in this set has a/c = 0.25, and the crack depth a/t ratio increases from 0.2 to 0.8 for the four cases. As the crack depth increases the crack length increases proportionally with the a/c ratio. The crack for Run 665 is long enough to have more curvature around the circumference of the cylinder compared to the other three cases. It appears that this additional curvature reduces the crack tip stress intensity compared to the crack tip values for the other cases. Figure 7-8 shows the crack front G_0 result plots for these four cases. At the crack depth location (non-dimensional crack front angle = 1.0 at the right side of the plot) the G_0 values increase with increasing crack depth as expected. The crack front results for Run 665 decrease more quickly than the other crack front trends near the crack tip (left side of the plot), likely due to the additional curvature of the longer crack around the cylinder. The lower crack tip value causes the A0 trend for a/t = 0.8 in Figure 7-7 to drop below the other trends at a/c = 0.25.

Figure 7-7: Compare the Circumferential Crack Sizes for a/c = 0.25, t/Ri = 2

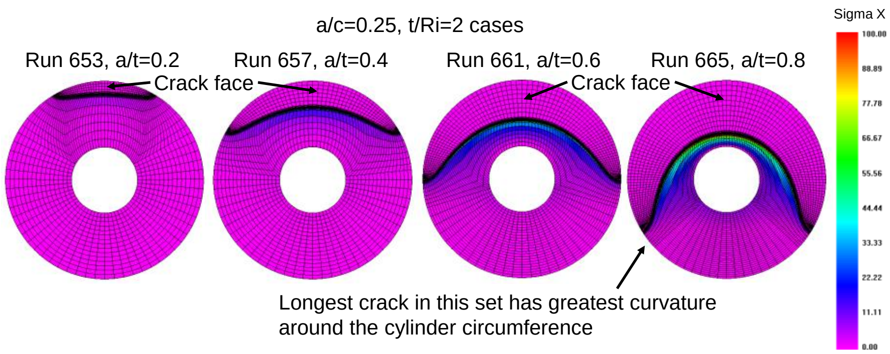
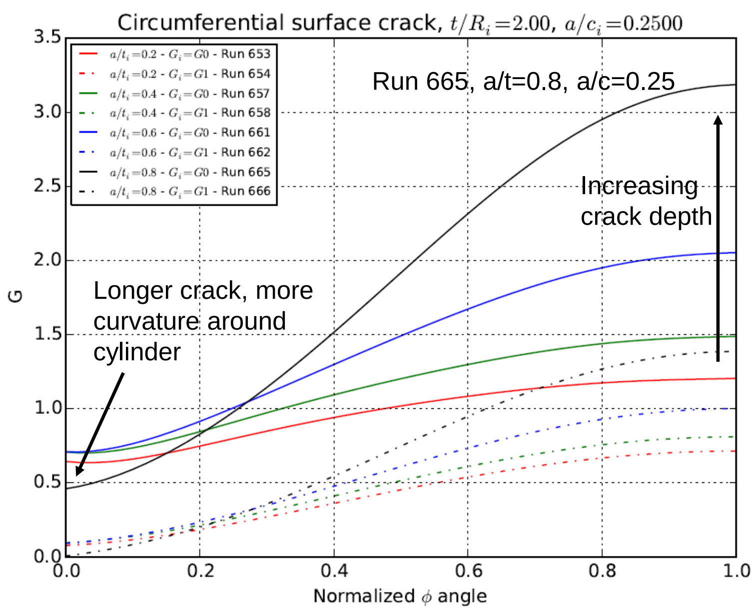


Figure 7-8: Compare the G_0 Crack Front results for a/c = 0.25, t/Ri = 2



Another non-intuitive result trend is found in the out-of-plane bending G_6 results where the G value at the crack tip drops (is more negative) and then rises again as the a/c ratio increases along the plot x-axis. Figure 7-9 shows the G result trend for Run 536, 552, and 568. The crack tip G value decreases (larger negative magnitude) when the crack length puts the crack tip near the 90° position around the side of cylinder circumference from the top of the cylinder. At the 90° location, the axial stress (sigma X) due to the out-of-plane bending has the largest magnitude, so the negative magnitude of the G result is larger (more negative) at the crack tip and causes the drop in the G result trend versus the a/c ratio.

Figure 7-10 shows an end view of the three circumferential crack meshes and the relative crack sizes as the a/c ratio changes from a longer crack to a shorter crack. Examining the crack sizes and crack tip position for each mesh explains the G_6 result trend. Run 536 is a longer surface crack with the crack tip near the bottom of the cylinder and close to the bending neutral axis (global Y-axis) where the bending stress (sigma X) is lower. The crack length for Run 552 puts the crack tip near the left side, 90° position, where the bending stress is largest, which gives a larger negative G value at the crack tip. The shorter crack length for Run 568 puts the crack tip in a lower bending stress region compared to Run 552, so the crack tip G result is less negative than Run 552, and more negative than Run 536.

Figure 7-9: Crack Tip result Trends for the G_6 Out-of-Plane Bending Load Case, t/Ri = 1.5

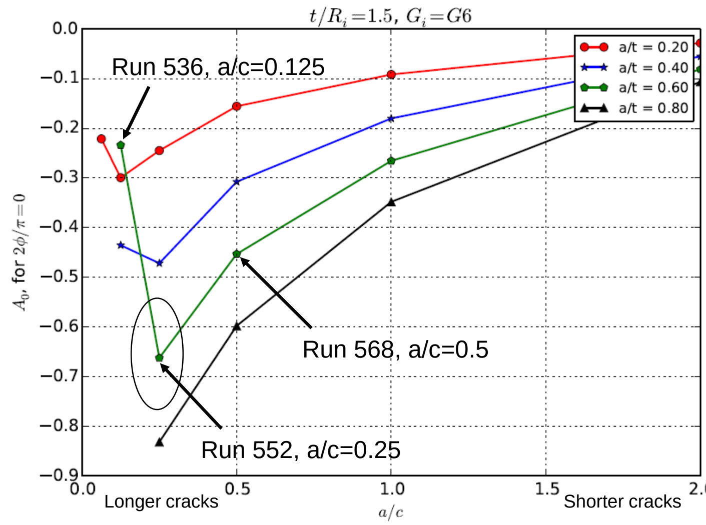
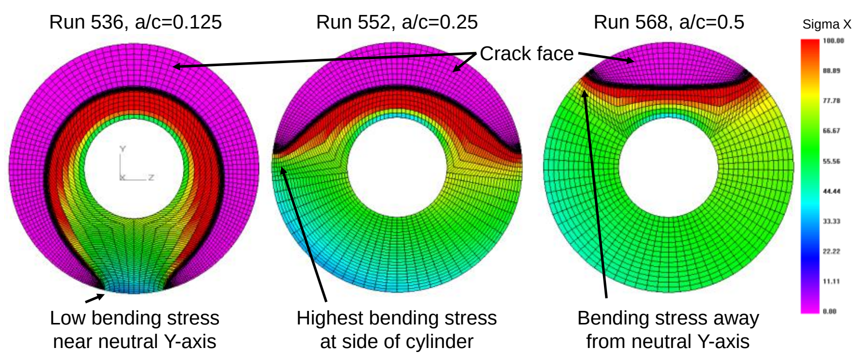


Figure 7-10: Compare Circumferential Crack Sizes for t/Ri = 1.5, a/t = 0.6



7.3 K from Displacement

The crack front stress intensity K is computed from the J-integral ("K from J") for all the cases in this report. Another check on the results and post processing is to use the independent calculation of K from the crack face opening displacement ("K from displacement"). The mode 1 crack opening K from displacement is computed using the equation:

$$K_I = 0.25E\frac{U_{\text{total}}}{2}\left(\frac{2\pi}{R}\right)^2 \quad (5)$$

where K_I is the mode 1 crack opening stress intensity due to the U_{total} crack face opening displacement between the crack faces at radial distance R from the crack front. Crack opening displacement equations are available for mode II and mode III, but are not needed, since the results are for mode I crack opening. Since the crack front node is at distance R = 0, it would cause a division by zero and cannot be used directly. Instead, crack face nodes away from the crack front along a radial mesh line are used to obtain a trend of stress intensity versus distance that is extrapolated back to the crack front.

As an example, Figure 7-11 and Figure 7-12 show plots comparing K from the crack opening displacement to K from the J-integral for eight axial external surface crack cases. The data points show the K from J values, and the solid curves show the K from displacement values. The close agreement in K values provides another indication that the crack mesh refinement is adequate to compute accurate K results. In Figure 7-12 there is a small difference in the K values at the crack tip, which often occurs in the K from J value at the crack tip node and is not unexpected.

Figure 7-11: K from Displacement Comparison to K from J for Axial External Surface Crack Cases 1, 3, 5, 7, Uniform Crack Face Pressure G_0 Load Case

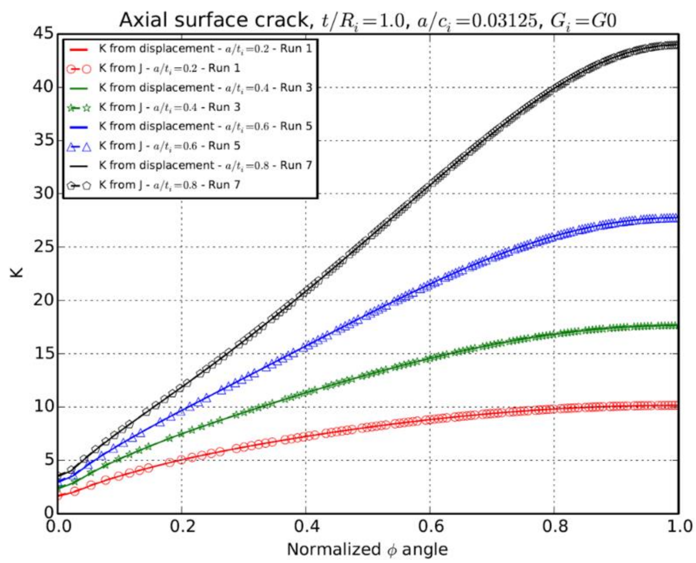
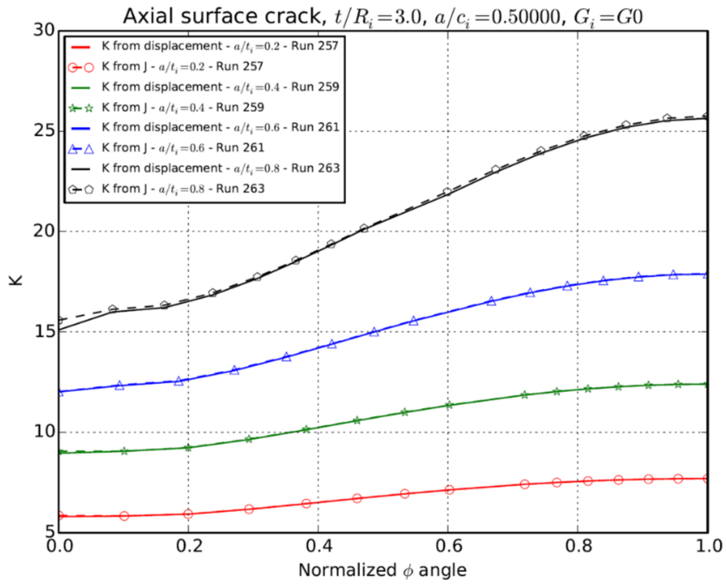


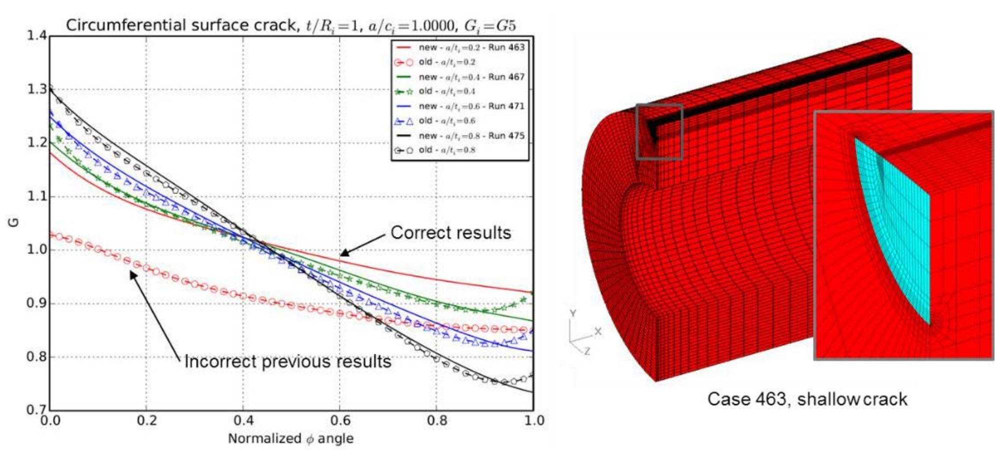
Figure 7-12: K from Displacement Comparison to K from J for Axial External Surface Crack Cases 257, 259, 261, 263, Uniform Crack Face Pressure G_0 Load Case



7.4 Incorrect Previous Results

The comparison of the results for the t/Ri = 1 cases to the previous results generally agree well (see appendices G, I, L, and N), except for case 463: t/Ri = 1, a/c = 1, a/t = 0.2, in-plane bending G_5, where the result trend was very different. In Figure 7-13 the solid red curve shows the new result along the crack front angle, and the previous results are shown by the red dashed curve with the circle data points. It is likely that the post-processing of the combined load case was not done properly for the previous result. By using the combined bending plus axial load and then subtracting the uniform load case results, the correct G_5 results are obtained for this case. We recommend updating this solution in the standard.

Figure 7-13: Results for Case 463 Show a Previous Result Error



8 SUMMARY

Stress intensity K factors were computed for external cracks in thick-walled cylinders. The 1040 cases include a range of geometry ratios and crack size ratios for external axial and external circumferential surface cracks, axial external full-width partial depth axial cracks, and circumferential external 360° partial depth cracks. These K solutions extend the K factor solutions available in the API 579-1/ASME FFS-1 Annex C tables.

The 3D crack meshes were created using the FEACrack™ software, and the analyses were run using the Abaqus™ finite element analysis software. A mesh convergence study examined a variety of mesh settings to confirm that adequate mesh refinement was used to compute the stress intensity values. The post processing included automatic and manual quality checks to confirm the results. Non-intuitive result trends were examined and explained. One previous result case was found to be in error and should be updated.

The results are reported as non-dimensional geometry factors that are tabulated in the appendices along with plots of all the result cases. The new solutions can be added to the API 579-1/ASME FFS-1 Annex C tables.

REFERENCES

[1] API 579-1/ASME FFS-1, American Petroleum Institute and the American Society of Mechanical Engineers, API Publishing Services, Washington, D.C., June 5, 2007.

[2] Thorwald, G., Parietti, L., Fletcher, B., and Wright, J., Quest Integrity Group, LLC, "Stress Intensity Factor Solutions for Internal Cracks in Thick-walled Cylinder Vessels for ASME RFP-ASME ST-14-04," ASME report STP-PT-072, ASME Standards Technology, LLC, New York, June 20, 2014.

[3] FEACrack™ software, version 3.2.29, Quest Integrity Group, http://www.questintegrity.com/products/feacrack-3D-crack-mesh-software .

[4] Anderson, T. L., et al, Development of Stress Intensity Factor Solutions for Surface and Embedded Cracks in API 579, WRC Bulletin 471, Welding Research Council, Inc., New York, May 2002.

[5] Anderson, T. L., Stress Intensity and Crack Growth Opening Area Solutions for Through-wall Cracks in Cylinders and Spheres, WRC Bulletin 478, Welding Research Council, Inc., New York, Jan. 2003.

[6] Abaqus™ software, version 6.14, Dassault Systèmes Simulia Corp., Johnston, RI.

[7] Anderson, T. L., Fracture Mechanics, Fundamentals and Applications, 3rd ed., CRC Press, Taylor & Francis Group, 2005, pp. 44-45.

APPENDIX A: AXIAL EXTERNAL CRACK RESULTS

The results table columns include ratios to describe each case and the polynomial coefficient values A0 through A6 for the non-dimensional geometry factor G. The "Run ID" case number uniquely identifies each model. The Y or t/Ri ratio describes the cylinder thickness ratio; the higher ratio values are the thicker cylinder models. The a/l or a/c ratio describes the crack length; the smaller ratios are the longer crack lengths. The a/t ratio describes the crack depth; the larger ratios are the deeper cracks. The Gi column indicates the load for each case: G0 is the uniform crack face pressure and G1 is the linear crack face pressure.

Table 5: Non-dimensional Geometry Polynomial Coefficient Values for Axial External Surface Cracks

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
1	2	0.015625	1	0.03125	0.2	G0	0.185121	3.188854	-6.482680	12.192272	-14.288081	8.601706	-2.111614
2	2	0.015625	1	0.03125	0.2	G1	0.002218	0.232860	2.374893	-3.194681	2.780956	-2.182333	0.733360
3	2	0.015625	1	0.03125	0.4	G0	0.186114	3.287193	-6.563730	14.505569	-18.263240	11.201917	-2.777015
4	2	0.015625	1	0.03125	0.4	G1	0.002129	0.244419	2.316128	-2.628722	2.563704	-2.603491	0.963885
5	2	0.015625	1	0.03125	0.6	G0	0.188529	3.325573	-5.996440	15.350206	-19.372323	11.119877	-2.589131
6	2	0.015625	1	0.03125	0.6	G1	0.002421	0.243116	2.368197	-2.400275	3.363615	-4.068738	1.519781
7	2	0.015625	1	0.03125	0.8	G0	0.193403	3.286405	-4.711590	14.618870	-18.272045	10.744648	-3.083255
8	2	0.015625	1	0.03125	0.8	G1	0.003669	0.213041	2.638151	-2.681828	4.617077	-4.830043	1.364246
9	2	0.03125	1	0.0625	0.2	G0	0.254806	2.438464	-2.740803	2.446353	-0.875988	-0.687926	0.443576
10	2	0.03125	1	0.0625	0.2	G1	0.010465	0.233153	2.333591	-3.084952	2.518702	-1.890349	0.623018
11	2	0.03125	1	0.0625	0.4	G0	0.258618	2.576236	-3.094962	5.335968	-5.228664	1.823073	-0.096923
12	2	0.03125	1	0.0625	0.4	G1	0.010878	0.251163	2.286781	-2.688509	2.727195	-2.730801	0.999490
13	2	0.03125	1	0.0625	0.6	G0	0.266687	2.626036	-2.801017	7.246477	-8.149369	3.160303	-0.328226
14	2	0.03125	1	0.0625	0.6	G1	0.011508	0.261788	2.275605	-2.310747	3.341409	-4.089143	1.534823
15	2	0.03125	1	0.0625	0.8	G0	0.279917	2.544139	-1.352379	6.101193	-6.363617	2.135462	-0.577863
16	2	0.03125	1	0.0625	0.8	G1	0.013438	0.234425	2.564528	-2.758745	5.032575	-5.335732	1.569031
17	2	0.0625	1	0.125	0.2	G0	0.388322	1.286602	2.053332	-8.581169	12.929838	-9.572280	2.754168
18	2	0.0625	1	0.125	0.2	G1	0.030700	0.241330	2.153705	-2.590769	1.660060	-1.144276	0.384660
19	2	0.0625	1	0.125	0.4	G0	0.408074	1.358016	2.369499	-8.562211	13.630668	-11.051005	3.394090
20	2	0.0625	1	0.125	0.4	G1	0.034870	0.249348	2.279726	-2.807760	2.678116	-2.448695	0.858520

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
21	2	0.0625	1	0.125	0.6	G0	0.434361	1.380693	2.944663	-8.351573	14.398774	-13.184658	4.362437
22	2	0.0625	1	0.125	0.6	G1	0.039336	0.250796	2.450632	-3.161382	4.487216	-4.742839	1.684563
23	2	0.0625	1	0.125	0.8	G0	0.473331	1.230496	4.682105	-10.876475	19.808960	-18.501541	5.890109
24	2	0.0625	1	0.125	0.8	G1	0.045855	0.202062	3.017214	-4.823454	8.779062	-8.675663	2.746608
25	2	0.125	1	0.25	0.2	G0	0.615729	-0.067194	5.790334	-14.635175	18.282435	-11.915994	3.144657
26	2	0.125	1	0.25	0.2	G1	0.075431	0.228618	1.928275	-2.083113	0.875100	-0.476420	0.174582
27	2	0.125	1	0.25	0.4	G0	0.674497	-0.090521	6.569872	-16.059304	20.391703	-13.774825	3.744274
28	2	0.125	1	0.25	0.4	G1	0.091794	0.223343	2.158106	-2.489912	1.628560	-1.230448	0.428502
29	2	0.125	1	0.25	0.6	G0	0.759811	-0.239972	8.146341	-19.163030	25.452277	-18.373719	5.256740
30	2	0.125	1	0.25	0.6	G1	0.112785	0.197789	2.547677	-3.295084	3.354686	-2.991099	1.022499
31	2	0.125	1	0.25	0.8	G0	0.870119	-0.490355	10.419374	-23.472844	33.315741	-26.026024	7.835043
32	2	0.125	1	0.25	0.8	G1	0.138002	0.151077	3.121397	-4.538513	6.309718	-5.970779	1.973660
33	2	0.25	1	0.5	0.2	G0	0.913372	-0.735043	4.471574	-8.246856	8.320446	-4.717293	1.140654
34	2	0.25	1	0.5	0.2	G1	0.141033	0.343450	1.103703	-0.636195	-0.557657	0.346388	-0.023693
35	2	0.25	1	0.5	0.4	G0	1.015207	-0.819177	4.919757	-8.801732	8.658853	-4.835082	1.155029
36	2	0.25	1	0.5	0.4	G1	0.172015	0.326617	1.221840	-0.739579	-0.544412	0.364228	-0.032381
37	2	0.25	1	0.5	0.6	G0	1.174108	-0.982447	5.673358	-9.634007	9.126974	-5.036430	1.202715
38	2	0.25	1	0.5	0.6	G1	0.219163	0.296282	1.388126	-0.790142	-0.689149	0.499359	-0.073851
39	2	0.25	1	0.5	0.8	G0	1.398706	-1.364577	7.678071	-12.977835	12.357364	-6.859392	1.632145
40	2	0.25	1	0.5	0.8	G1	0.285589	0.171801	2.172638	-2.304679	0.996312	-0.452797	0.110046
41	2	0.5	1	1	0.2	G0	1.258829	-0.920383	2.464641	-4.643045	5.586619	-3.692533	1.007931
42	2	0.5	1	1	0.2	G1	0.204376	0.551618	1.038902	-2.136340	1.961327	-1.226688	0.345303
43	2	0.5	1	1	0.4	G0	1.358991	-1.000057	2.426376	-4.298265	5.004235	-3.246678	0.877984
44	2	0.5	1	1	0.4	G1	0.233727	0.546132	0.974941	-1.932976	1.666765	-1.014210	0.285017
45	2	0.5	1	1	0.6	G0	1.513798	-1.174129	2.592991	-4.334109	4.883126	-3.111444	0.837530
46	2	0.5	1	1	0.6	G1	0.278808	0.520717	0.939526	-1.754995	1.382899	-0.804174	0.226268
47	2	0.5	1	1	0.8	G0	1.722292	-1.472304	3.210428	-5.674377	6.979236	-4.950340	1.489916
48	2	0.5	1	1	0.8	G1	0.338285	0.461023	1.079305	-2.155003	2.109173	-1.450342	0.444958
49	2	1	1	2	0.2	G0	0.849913	-0.623478	0.993801	-1.666592	1.334505	-0.679852	0.286499

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
50	2	1	1	2	0.2	G1	0.114055	0.522567	0.443598	-0.722333	-0.788050	1.041518	-0.213190
51	2	1	1	2	0.4	G0	0.888847	-0.681988	0.956069	-1.405765	0.933773	-0.394995	0.208109
52	2	1	1	2	0.4	G1	0.123935	0.520367	0.390497	-0.579710	-0.970714	1.165073	-0.247663
53	2	1	1	2	0.6	G0	0.941188	-0.763541	0.916824	-1.073695	0.401173	0.006239	0.089259
54	2	1	1	2	0.6	G1	0.137170	0.516798	0.312866	-0.346017	-1.305150	1.420120	-0.327824
55	2	1	1	2	0.8	G0	1.002158	-0.820483	0.610344	0.027135	-1.168765	1.077598	-0.195853
56	2	1	1	2	0.8	G1	0.151742	0.526825	0.141814	0.139733	-1.967186	1.891335	-0.467090
57	2.5	0.015625	1.5	0.03125	0.2	G0	0.184316	3.185155	-6.416255	12.046791	-14.275538	8.738850	-2.183521
58	2.5	0.015625	1.5	0.03125	0.2	G1	0.002013	0.230347	2.375843	-3.137204	2.600897	-1.998878	0.671756
59	2.5	0.015625	1.5	0.03125	0.4	G0	0.184814	3.260433	-6.215264	13.110697	-16.327198	10.012541	-2.490388
60	2.5	0.015625	1.5	0.03125	0.4	G1	0.001931	0.235164	2.368206	-2.719061	2.445339	-2.348690	0.859605
61	2.5	0.015625	1.5	0.03125	0.6	G0	0.186266	3.287464	-5.493228	12.836395	-15.634565	8.769382	-2.026212
62	2.5	0.015625	1.5	0.03125	0.6	G1	0.002280	0.226408	2.484911	-2.743251	3.420877	-3.756126	1.355909
63	2.5	0.015625	1.5	0.03125	0.8	G0	0.191146	3.204060	-3.742848	9.462399	-10.002877	5.397123	-1.873971
64	2.5	0.015625	1.5	0.03125	0.8	G1	0.004001	0.174807	2.957877	-3.844780	5.752158	-5.002880	1.230486
65	2.5	0.03125	1.5	0.0625	0.2	G0	0.253290	2.432384	-2.700331	2.471102	-1.119732	-0.404040	0.344474
66	2.5	0.03125	1.5	0.0625	0.2	G1	0.009893	0.230422	2.326090	-3.003587	2.352958	-1.757793	0.585317
67	2.5	0.03125	1.5	0.0625	0.4	G0	0.255655	2.530458	-2.774915	4.458076	-4.467570	1.684671	-0.149831
68	2.5	0.03125	1.5	0.0625	0.4	G1	0.009796	0.243346	2.281730	-2.546274	2.265995	-2.248178	0.836391
69	2.5	0.03125	1.5	0.0625	0.6	G0	0.262267	2.527752	-2.052348	4.534908	-4.651024	1.251086	0.052376
70	2.5	0.03125	1.5	0.0625	0.6	G1	0.010197	0.243625	2.330894	-2.359678	2.926329	-3.438524	1.277687
71	2.5	0.03125	1.5	0.0625	0.8	G0	0.274290	2.369461	0.099091	0.075723	2.647639	-3.504190	0.668769
72	2.5	0.03125	1.5	0.0625	0.8	G1	0.012280	0.193341	2.809407	-3.538519	5.530894	-5.046760	1.308709
73	2.5	0.0625	1.5	0.125	0.2	G0	0.386288	1.280467	2.090667	-8.562532	12.814964	-9.469762	2.724578
74	2.5	0.0625	1.5	0.125	0.2	G1	0.029657	0.239008	2.150670	-2.542268	1.596761	-1.117368	0.381590
75	2.5	0.0625	1.5	0.125	0.4	G0	0.400115	1.336465	2.405097	-8.395378	12.969802	-10.352825	3.160916
76	2.5	0.0625	1.5	0.125	0.4	G1	0.031774	0.244066	2.247193	-2.631456	2.350692	-2.191296	0.785879
77	2.5	0.0625	1.5	0.125	0.6	G0	0.419060	1.330162	3.066041	-8.484680	13.752128	-12.078859	3.905009
78	2.5	0.0625	1.5	0.125	0.6	G1	0.034120	0.241769	2.394287	-2.898770	3.863367	-4.134184	1.481921

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
79	2.5	0.0625	1.5	0.125	0.8	G0	0.450640	1.107318	5.318707	-13.164656	22.226266	-18.887038	5.545016
80	2.5	0.0625	1.5	0.125	0.8	G1	0.038939	0.178025	3.047153	-4.891072	8.397487	-7.887477	2.369623
81	2.5	0.125	1.5	0.25	0.2	G0	0.615372	-0.065515	5.809641	-14.606558	18.215796	-11.880799	3.138708
82	2.5	0.125	1.5	0.25	0.2	G1	0.074698	0.229962	1.926585	-2.052209	0.841826	-0.470611	0.176804
83	2.5	0.125	1.5	0.25	0.4	G0	0.662416	-0.081773	6.514915	-15.788232	20.001912	-13.538879	3.688763
84	2.5	0.125	1.5	0.25	0.4	G1	0.086500	0.227179	2.125731	-2.375532	1.523831	-1.207143	0.431843
85	2.5	0.125	1.5	0.25	0.6	G0	0.726958	-0.216407	7.957721	-18.661309	24.880919	-18.044617	5.171054
86	2.5	0.125	1.5	0.25	0.6	G1	0.100550	0.205054	2.477465	-3.152103	3.307250	-3.042097	1.047174
87	2.5	0.125	1.5	0.25	0.8	G0	0.809636	-0.470411	10.327561	-23.997312	35.022219	-27.404207	8.132174
88	2.5	0.125	1.5	0.25	0.8	G1	0.117672	0.153798	3.101297	-4.814905	7.150848	-6.676981	2.144661
89	2.5	0.25	1.5	0.5	0.2	G0	0.918760	-0.731705	4.461155	-8.157896	8.154855	-4.591132	1.104276
90	2.5	0.25	1.5	0.5	0.2	G1	0.142181	0.346826	1.093846	-0.591198	-0.631186	0.398937	-0.038268
91	2.5	0.25	1.5	0.5	0.4	G0	1.014734	-0.806287	4.926832	-8.766690	8.619895	-4.841968	1.164709
92	2.5	0.25	1.5	0.5	0.4	G1	0.170424	0.334969	1.215051	-0.709426	-0.569783	0.361184	-0.027134
93	2.5	0.25	1.5	0.5	0.6	G0	1.151961	-0.926971	5.590295	-9.448657	9.065317	-5.134747	1.251319
94	2.5	0.25	1.5	0.5	0.6	G1	0.209831	0.320543	1.345255	-0.693470	-0.738510	0.472814	-0.056995
95	2.5	0.25	1.5	0.5	0.8	G0	1.344390	-1.307328	7.957435	-14.256834	15.026217	-9.090496	2.246829
96	2.5	0.25	1.5	0.5	0.8	G1	0.266328	0.192432	2.270080	-2.739631	1.899766	-1.209805	0.319291
97	2.5	0.5	1.5	1	0.2	G0	1.269270	-0.926747	2.450385	-4.590910	5.520803	-3.653224	0.998752
98	2.5	0.5	1.5	1	0.2	G1	0.207128	0.552641	1.030480	-2.122401	1.952870	-1.226323	0.346278
99	2.5	0.5	1.5	1	0.4	G0	1.375650	-1.005464	2.400550	-4.206794	4.874890	-3.157636	0.853770
100	2.5	0.5	1.5	1	0.4	G1	0.237601	0.553017	0.945241	-1.865891	1.581884	-0.958034	0.269995
101	2.5	0.5	1.5	1	0.6	G0	1.529898	-1.163602	2.572592	-4.335524	4.967567	-3.218453	0.876237
102	2.5	0.5	1.5	1	0.6	G1	0.281949	0.536231	0.906808	-1.717306	1.371421	-0.816256	0.233496
103	2.5	0.5	1.5	1	0.8	G0	1.737002	-1.478165	3.530955	-6.973022	9.381206	-6.964274	2.110376
104	2.5	0.5	1.5	1	0.8	G1	0.341452	0.472790	1.153664	-2.548005	2.869377	-2.103032	0.651677
105	2.5	1	1.5	2	0.2	G0	0.855544	-0.633346	0.990689	-1.634631	1.290258	-0.652614	0.280001
106	2.5	1	1.5	2	0.2	G1	0.115362	0.522373	0.436511	-0.708057	-0.799248	1.045258	-0.213580
107	2.5	1	1.5	2	0.4	G0	0.899631	-0.698248	0.933905	-1.296840	0.774931	-0.284849	0.177806

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
108	2.5	1	1.5	2	0.4	G1	0.126255	0.522508	0.363424	-0.511614	-1.057594	1.224395	-0.264591
109	2.5	1	1.5	2	0.6	G0	0.956020	-0.780211	0.864055	-0.883791	0.151258	0.165946	0.048131
110	2.5	1	1.5	2	0.6	G1	0.140261	0.522339	0.268634	-0.245630	-1.423882	1.497162	-0.349307
111	2.5	1	1.5	2	0.8	G0	1.021343	-0.839868	0.571171	0.097254	-1.115601	0.941571	-0.136834
112	2.5	1	1.5	2	0.8	G1	0.156211	0.531405	0.112872	0.151992	-1.911480	1.820393	-0.442582
113	3	0.015625	2	0.03125	0.2	G0	0.183817	3.190141	-6.404381	12.027995	-14.359563	8.885385	-2.245389
114	3	0.015625	2	0.03125	0.2	G1	0.001926	0.229118	2.378913	-3.109083	2.499532	-1.891250	0.634664
115	3	0.015625	2	0.03125	0.4	G0	0.184160	3.251914	-6.019747	12.299556	-15.140288	9.231722	-2.288792
116	3	0.015625	2	0.03125	0.4	G1	0.001874	0.229989	2.405622	-2.795416	2.433543	-2.257482	0.817933
117	3	0.015625	2	0.03125	0.6	G0	0.185025	3.279455	-5.256690	11.563108	-13.649886	7.443417	-1.684608
118	3	0.015625	2	0.03125	0.6	G1	0.002242	0.218161	2.552444	-2.944665	3.510824	-3.661237	1.296263
119	3	0.015625	2	0.03125	0.8	G0	0.189573	3.190190	-3.412899	7.384079	-6.587833	3.139315	-1.338270
120	3	0.015625	2	0.03125	0.8	G1	0.004080	0.160315	3.088812	-4.322541	6.191462	-5.062445	1.184316
121	3	0.03125	2	0.0625	0.2	G0	0.252448	2.433414	-2.689516	2.524077	-1.330543	-0.179648	0.267593
122	3	0.03125	2	0.0625	0.2	G1	0.009595	0.229567	2.319399	-2.944170	2.232762	-1.660824	0.557292
123	3	0.03125	2	0.0625	0.4	G0	0.254507	2.504975	-2.545742	3.787884	-3.747995	1.380155	-0.113186
124	3	0.03125	2	0.0625	0.4	G1	0.009338	0.239318	2.284590	-2.475733	2.015254	-1.980787	0.745002
125	3	0.03125	2	0.0625	0.6	G0	0.260573	2.477816	-1.588111	2.819232	-2.283418	-0.200328	0.394940
126	3	0.03125	2	0.0625	0.6	G1	0.009706	0.233960	2.373812	-2.421281	2.762152	-3.141390	1.157288
127	3	0.03125	2	0.0625	0.8	G0	0.271854	2.296694	0.811610	-2.957080	7.257252	-6.507686	1.389068
128	3	0.03125	2	0.0625	0.8	G1	0.011838	0.175439	2.924836	-3.887263	5.713223	-4.891194	1.195655
129	3	0.0625	2	0.125	0.2	G0	0.385244	1.277902	2.116594	-8.559753	12.754388	-9.414360	2.709228
130	3	0.0625	2	0.125	0.2	G1	0.029082	0.237897	2.148968	-2.512087	1.557427	-1.101592	0.380342
131	3	0.0625	2	0.125	0.4	G0	0.396455	1.326541	2.435886	-8.299013	12.527264	-9.868930	2.995677
132	3	0.0625	2	0.125	0.4	G1	0.030255	0.242687	2.222371	-2.497910	2.097851	-1.990301	0.728675
133	3	0.0625	2	0.125	0.6	G0	0.412667	1.302436	3.191425	-8.695131	13.488752	-11.462037	3.633573
134	3	0.0625	2	0.125	0.6	G1	0.031797	0.239434	2.354123	-2.691984	3.376535	-3.670905	1.330592
135	3	0.0625	2	0.125	0.8	G0	0.441614	1.043702	5.729282	-14.523178	23.512617	-18.992922	5.325051
136	3	0.0625	2	0.125	0.8	G1	0.035993	0.171140	3.027231	-4.733296	7.780323	-7.123558	2.072234

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
137	3	0.125	2	0.25	0.2	G0	0.615397	-0.066314	5.839456	-14.641843	18.254930	-11.919328	3.152584
138	3	0.125	2	0.25	0.2	G1	0.074293	0.230222	1.930705	-2.048287	0.845516	-0.486068	0.183853
139	3	0.125	2	0.25	0.4	G0	0.656255	-0.075740	6.484539	-15.617332	19.728076	-13.355956	3.642522
140	3	0.125	2	0.25	0.4	G1	0.083628	0.229768	2.106178	-2.303216	1.451316	-1.184988	0.431647
141	3	0.125	2	0.25	0.6	G0	0.711262	-0.201332	7.849369	-18.315682	24.341573	-17.633459	5.048508
142	3	0.125	2	0.25	0.6	G1	0.094499	0.210035	2.433543	-3.041827	3.201758	-2.996266	1.037904
143	3	0.125	2	0.25	0.8	G0	0.782605	-0.460564	10.283615	-24.129380	35.258564	-27.325253	7.985350
144	3	0.125	2	0.25	0.8	G1	0.108363	0.156910	3.073152	-4.843272	7.255263	-6.691018	2.108915
145	3	0.25	2	0.5	0.2	G0	0.922532	-0.730699	4.461298	-8.110854	8.050518	-4.503858	1.077300
146	3	0.25	2	0.5	0.2	G1	0.142994	0.348797	1.088657	-0.561740	-0.684130	0.439705	-0.050299
147	3	0.25	2	0.5	0.4	G0	1.015035	-0.799312	4.939552	-8.766831	8.627855	-4.870363	1.177730
148	3	0.25	2	0.5	0.4	G1	0.169531	0.339974	1.213310	-0.697565	-0.574213	0.350034	-0.021074
149	3	0.25	2	0.5	0.6	G0	1.139643	-0.894057	5.537861	-9.334050	9.014844	-5.174226	1.272398
150	3	0.25	2	0.5	0.6	G1	0.204311	0.335213	1.318565	-0.635797	-0.767436	0.458348	-0.048112
151	3	0.25	2	0.5	0.8	G0	1.315050	-1.291944	8.202086	-15.229076	16.745919	-10.319619	2.524101
152	3	0.25	2	0.5	0.8	G1	0.255458	0.197858	2.359749	-3.085373	2.499094	-1.631376	0.412073
153	3	0.5	2	1	0.2	G0	1.276263	-0.928654	2.425219	-4.503400	5.388660	-3.556694	0.971288
154	3	0.5	2	1	0.2	G1	0.208947	0.554525	1.016847	-2.086479	1.903448	-1.191741	0.336644
155	3	0.5	2	1	0.4	G0	1.387164	-1.009504	2.385733	-4.154137	4.801173	-3.107119	0.840098
156	3	0.5	2	1	0.4	G1	0.240279	0.557502	0.926478	-1.824362	1.529570	-0.923380	0.260734
157	3	0.5	2	1	0.6	G0	1.540974	-1.159967	2.580554	-4.416389	5.156272	-3.391263	0.931638
158	3	0.5	2	1	0.6	G1	0.283941	0.546969	0.883818	-1.692805	1.365658	-0.824507	0.237811
159	3	0.5	2	1	0.8	G0	1.743113	-1.436305	3.448360	-6.982904	9.660351	-7.265219	2.198656
160	3	0.5	2	1	0.8	G1	0.340654	0.519463	0.958668	-2.087481	2.261394	-1.677544	0.528115
161	3	1	2	2	0.2	G0	0.859353	-0.639193	0.984123	-1.599085	1.237097	-0.615546	0.269938
162	3	1	2	2	0.2	G1	0.116246	0.522528	0.430057	-0.692503	-0.817263	1.056307	-0.216427
163	3	1	2	2	0.4	G0	0.907007	-0.708775	0.916198	-1.217549	0.661203	-0.206523	0.156332
164	3	1	2	2	0.4	G1	0.127841	0.524094	0.344591	-0.464696	-1.117326	1.265231	-0.276270
165	3	1	2	2	0.6	G0	0.966075	-0.790014	0.820213	-0.741526	-0.027120	0.275480	0.020834

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
166	3	1	2	2	0.6	G1	0.142316	0.526518	0.237548	-0.178510	-1.499234	1.544221	-0.362234
167	3	1	2	2	0.8	G0	1.033509	-0.842482	0.493121	0.237477	-1.143199	0.854352	-0.089605
168	3	1	2	2	0.8	G1	0.158640	0.541374	0.060230	0.228912	-1.941684	1.803042	-0.430836
169	3.5	0.015625	2.5	0.03125	0.2	G0	0.183444	3.199596	-6.422436	12.078825	-14.497761	9.038508	-2.302152
170	3.5	0.015625	2.5	0.03125	0.2	G1	0.001887	0.228343	2.384046	-3.099658	2.445619	-1.828799	0.612191
171	3.5	0.015625	2.5	0.03125	0.4	G0	0.183765	3.250679	-5.904333	11.812501	-14.408678	8.732614	-2.155050
172	3.5	0.015625	2.5	0.03125	0.4	G1	0.001853	0.226912	2.431474	-2.848506	2.443648	-2.221701	0.799780
173	3.5	0.015625	2.5	0.03125	0.6	G0	0.184234	3.281586	-5.140124	10.899403	-12.608055	6.736571	-1.496977
174	3.5	0.015625	2.5	0.03125	0.6	G1	0.002214	0.214059	2.589481	-3.046237	3.544396	-3.603234	1.264639
175	3.5	0.015625	2.5	0.03125	0.8	G0	0.188392	3.197908	-3.324473	6.598755	-5.340667	2.352183	-1.151632
176	3.5	0.015625	2.5	0.03125	0.8	G1	0.004029	0.155917	3.131920	-4.465780	6.236356	-4.979185	1.143045
177	3.5	0.03125	2.5	0.0625	0.2	G0	0.251899	2.437615	-2.693094	2.585700	-1.507845	-0.003070	0.208182
178	3.5	0.03125	2.5	0.0625	0.2	G1	0.009421	0.229388	2.314556	-2.901484	2.146220	-1.590598	0.536746
179	3.5	0.03125	2.5	0.0625	0.4	G0	0.254012	2.489415	-2.379965	3.293148	-3.167766	1.081907	-0.056920
180	3.5	0.03125	2.5	0.0625	0.4	G1	0.009110	0.236825	2.290024	-2.438631	1.870795	-1.825213	0.691604
181	3.5	0.03125	2.5	0.0625	0.6	G0	0.259776	2.450591	-1.292649	1.732248	-0.750743	-1.182894	0.641780
182	3.5	0.03125	2.5	0.0625	0.6	G1	0.009473	0.228480	2.402104	-2.458326	2.667535	-2.974973	1.091540
183	3.5	0.03125	2.5	0.0625	0.8	G0	0.270440	2.266674	1.166617	-4.475061	9.499801	-7.958250	1.748887
184	3.5	0.03125	2.5	0.0625	0.8	G1	0.011561	0.168280	2.968405	-3.986635	5.648062	-4.702266	1.117938
185	3.5	0.0625	2.5	0.125	0.2	G0	0.384663	1.277033	2.136435	-8.566811	12.727903	-9.389030	2.702884
186	3.5	0.0625	2.5	0.125	0.2	G1	0.028735	0.237340	2.148238	-2.492498	1.532310	-1.092683	0.380217
187	3.5	0.0625	2.5	0.125	0.4	G0	0.394594	1.321356	2.462736	-8.239715	12.220739	-9.527499	2.877572
188	3.5	0.0625	2.5	0.125	0.4	G1	0.029413	0.242560	2.204218	-2.397942	1.908557	-1.840422	0.686061
189	3.5	0.0625	2.5	0.125	0.6	G0	0.409622	1.284876	3.301431	-8.894339	13.383426	-11.099699	3.467004
190	3.5	0.0625	2.5	0.125	0.6	G1	0.030575	0.239125	2.325401	-2.533559	3.011120	-3.331759	1.221865
191	3.5	0.0625	2.5	0.125	0.8	G0	0.437294	1.009803	5.977919	-15.261234	24.027669	-18.826864	5.133279
192	3.5	0.0625	2.5	0.125	0.8	G1	0.034428	0.170872	2.987178	-4.502175	7.144780	-6.462467	1.842354
193	3.5	0.125	2.5	0.25	0.2	G0	0.615611	-0.068564	5.876234	-14.716634	18.358809	-12.002946	3.178561
194	3.5	0.125	2.5	0.25	0.2	G1	0.074069	0.229902	1.938052	-2.059174	0.868887	-0.512294	0.193183

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
195	3.5	0.125	2.5	0.25	0.4	G0	0.652911	-0.070685	6.463282	-15.488954	19.509680	-13.203103	3.602789
196	3.5	0.125	2.5	0.25	0.4	G1	0.081945	0.231799	2.092742	-2.250977	1.394776	-1.164288	0.430115
197	3.5	0.125	2.5	0.25	0.6	G0	0.702939	-0.188350	7.761673	-17.986916	23.755980	-17.155813	4.903291
198	3.5	0.125	2.5	0.25	0.6	G1	0.091139	0.214542	2.397243	-2.930525	3.051347	-2.897374	1.011401
199	3.5	0.125	2.5	0.25	0.8	G0	0.768697	-0.449129	10.211235	-23.920592	34.664269	-26.549447	7.650901
200	3.5	0.125	2.5	0.25	0.8	G1	0.103373	0.162129	3.026949	-4.715295	6.993910	-6.400747	1.991146
201	3.5	0.25	2.5	0.5	0.2	G0	0.925405	-0.731616	4.471464	-8.099602	7.997869	-4.449917	1.058505
202	3.5	0.25	2.5	0.5	0.2	G1	0.143627	0.349792	1.087210	-0.544051	-0.721795	0.471900	-0.060583
203	3.5	0.25	2.5	0.5	0.4	G0	1.015857	-0.795439	4.955212	-8.788170	8.668248	-4.918377	1.195647
204	3.5	0.25	2.5	0.5	0.4	G1	0.169085	0.343071	1.214971	-0.698492	-0.561795	0.329513	-0.012846
205	3.5	0.25	2.5	0.5	0.6	G0	1.132767	-0.870665	5.489081	-9.219404	8.925593	-5.161723	1.276347
206	3.5	0.25	2.5	0.5	0.6	G1	0.200980	0.345129	1.299407	-0.596200	-0.785258	0.445915	-0.041017
207	3.5	0.25	2.5	0.5	0.8	G0	1.298710	-1.289578	8.374998	-15.847276	17.685595	-10.850138	2.587584
208	3.5	0.25	2.5	0.5	0.8	G1	0.249121	0.197340	2.434467	-3.343382	2.883138	-1.848629	0.439847
209	3.5	0.5	2.5	1	0.2	G0	1.281305	-0.928798	2.398643	-4.409085	5.237176	-3.439958	0.936634
210	3.5	0.5	2.5	1	0.2	G1	0.210243	0.556631	1.001780	-2.041925	1.835580	-1.140612	0.321636
211	3.5	0.5	2.5	1	0.4	G0	1.395762	-1.012974	2.378157	-4.127026	4.765460	-3.083804	0.834032
212	3.5	0.5	2.5	1	0.4	G1	0.242294	0.560582	0.913818	-1.797041	1.495320	-0.900481	0.254532
213	3.5	0.5	2.5	1	0.6	G0	1.549665	-1.162078	2.617463	-4.592160	5.497825	-3.682390	1.022477
214	3.5	0.5	2.5	1	0.6	G1	0.285352	0.556539	0.856485	-1.650577	1.330870	-0.809509	0.234814
215	3.5	0.5	2.5	1	0.8	G0	1.740405	-1.275340	2.537561	-4.431676	5.915260	-4.472444	1.365011
216	3.5	0.5	2.5	1	0.8	G1	0.334891	0.642412	0.247244	-0.047423	-0.795772	0.613602	-0.148998
217	3.5	1	2.5	2	0.2	G0	0.862132	-0.643046	0.977353	-1.566126	1.184830	-0.576499	0.258643
218	3.5	1	2.5	2	0.2	G1	0.116897	0.522701	0.424937	-0.678476	-0.836705	1.070395	-0.220548
219	3.5	1	2.5	2	0.4	G0	0.912387	-0.715911	0.900375	-1.152978	0.570163	-0.144516	0.139509
220	3.5	1	2.5	2	0.4	G1	0.129001	0.525345	0.330472	-0.429895	-1.161259	1.295041	-0.284742
221	3.5	1	2.5	2	0.6	G0	0.973340	-0.795119	0.777879	-0.622157	-0.159838	0.344795	0.006808
222	3.5	1	2.5	2	0.6	G1	0.143761	0.530378	0.211730	-0.128108	-1.546185	1.566828	-0.367043
223	3.5	1	2.5	2	0.8	G0	1.040515	-0.814495	0.269682	0.741048	-1.635648	1.056751	-0.112083

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
224	3.5	1	2.5	2	0.8	G1	0.159141	0.567962	-0.084423	0.546320	-2.283229	1.980888	-0.466493
225	4	0.015625	3	0.03125	0.2	G0	0.183142	3.211368	-6.455417	12.161009	-14.651499	9.181976	-2.351537
226	4	0.015625	3	0.03125	0.2	G1	0.001872	0.227742	2.391052	-3.103323	2.423686	-1.796792	0.599680
227	4	0.015625	3	0.03125	0.4	G0	0.183513	3.251910	-5.830150	11.501600	-13.936013	8.402556	-2.064365
228	4	0.015625	3	0.03125	0.4	G1	0.001843	0.224981	2.449524	-2.883923	2.455328	-2.206499	0.791327
229	4	0.015625	3	0.03125	0.6	G0	0.183702	3.286781	-5.080762	10.546551	-12.063968	6.369991	-1.398072
230	4	0.015625	3	0.03125	0.6	G1	0.002187	0.212028	2.609400	-3.091462	3.538008	-3.552750	1.243160
231	4	0.015625	3	0.03125	0.8	G0	0.187494	3.211646	-3.328841	6.371265	-5.040577	2.206727	-1.117011
232	4	0.015625	3	0.03125	0.8	G1	0.003931	0.155695	3.136961	-4.463766	6.118906	-4.844755	1.106976
233	4	0.03125	3	0.0625	0.2	G0	0.251505	2.443076	-2.702545	2.644211	-1.651214	0.133274	0.163013
234	4	0.03125	3	0.0625	0.2	G1	0.009310	0.229435	2.311634	-2.871569	2.084858	-1.540746	0.522105
235	4	0.03125	3	0.0625	0.4	G0	0.253788	2.479416	-2.258966	2.931359	-2.724406	0.833600	-0.003410
236	4	0.03125	3	0.0625	0.4	G1	0.008984	0.235170	2.295402	-2.416637	1.781070	-1.729070	0.658714
237	4	0.03125	3	0.0625	0.6	G0	0.259335	2.435369	-1.100795	1.038238	0.229061	-1.822915	0.807820
238	4	0.03125	3	0.0625	0.6	G1	0.009338	0.225351	2.419062	-2.471284	2.592115	-2.863473	1.050189
239	4	0.03125	3	0.0625	0.8	G0	0.269492	2.255555	1.346372	-5.232093	10.545055	-8.612727	1.918617
240	4	0.03125	3	0.0625	0.8	G1	0.011346	0.166068	2.977216	-3.968303	5.474885	-4.506582	1.058789
241	4	0.0625	3	0.125	0.2	G0	0.384319	1.277009	2.152071	-8.577009	12.717025	-9.377618	2.700566
242	4	0.0625	3	0.125	0.2	G1	0.028510	0.237059	2.148050	-2.478948	1.515209	-1.087487	0.380637
243	4	0.0625	3	0.125	0.4	G0	0.393563	1.318776	2.482892	-8.192465	11.988701	-9.271768	2.789076
244	4	0.0625	3	0.125	0.4	G1	0.028897	0.242950	2.190022	-2.319799	1.762802	-1.726414	0.653816
245	4	0.0625	3	0.125	0.6	G0	0.408070	1.272278	3.395628	-9.064693	13.342586	-10.869865	3.358090
246	4	0.0625	3	0.125	0.6	G1	0.029858	0.239450	2.304238	-2.410452	2.733990	-3.080759	1.142811
247	4	0.0625	3	0.125	0.8	G0	0.434987	0.990884	6.130310	-15.641141	24.115680	-18.517069	4.957879
248	4	0.0625	3	0.125	0.8	G1	0.033475	0.173151	2.941916	-4.261616	6.564808	-5.911841	1.664399
249	4	0.125	3	0.25	0.2	G0	0.615903	-0.071240	5.913565	-14.804158	18.485314	-12.102126	3.208693
250	4	0.125	3	0.25	0.2	G1	0.073945	0.229315	1.946665	-2.077022	0.901394	-0.543300	0.203516
251	4	0.125	3	0.25	0.4	G0	0.650951	-0.065130	6.438863	-15.362736	19.296125	-13.051053	3.562550
252	4	0.125	3	0.25	0.4	G1	0.080877	0.233784	2.080691	-2.204660	1.340499	-1.140070	0.426652

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
253	4	0.125	3	0.25	0.6	G0	0.698028	-0.173009	7.652069	-17.555767	22.976485	-16.517049	4.708637
254	4	0.125	3	0.25	0.6	G1	0.089058	0.219818	2.355831	-2.788305	2.831691	-2.736629	0.965584
255	4	0.125	3	0.25	0.8	G0	0.760777	-0.434999	10.101610	-23.465464	33.581563	-25.410509	7.228544
256	4**	0.125	3	0.25	0.8	G1	0.100377	0.168715	2.968170	-4.501481	6.558589	-5.980828	1.842492
257	4	0.25	3	0.5	0.2	G0	0.927721	-0.734077	4.490784	-8.121851	7.998050	-4.434564	1.050624
258	4	0.25	3	0.5	0.2	G1	0.144151	0.350002	1.089497	-0.538932	-0.740380	0.490495	-0.067075
259	4	0.25	3	0.5	0.4	G0	1.016900	-0.793250	4.973102	-8.828964	8.744950	-4.994325	1.221928
260	4	0.25	3	0.5	0.4	G1	0.168895	0.344937	1.219752	-0.712142	-0.529605	0.295204	-0.000773
261	4	0.25	3	0.5	0.6	G0	1.128682	-0.848856	5.420969	-9.058890	8.780491	-5.118730	1.275788
262	4	0.25	3	0.5	0.6	G1	0.198871	0.352706	1.283825	-0.573117	-0.772783	0.407538	-0.025104
263	4	0.25	3	0.5	0.8	G0	1.289411	-1.294120	8.506556	-16.285868	18.298031	-11.132689	2.585888
264	4	0.25	3	0.5	0.8	G1	0.245426	0.190997	2.520463	-3.628440	3.301235	-2.091606	0.476155
265	4	0.5	3	1	0.2	G0	1.285157	-0.928199	2.373199	-4.316803	5.083796	-3.318708	0.900009
266	4	0.5	3	1	0.2	G1	0.211214	0.558843	0.985963	-1.992546	1.757365	-1.080319	0.303715
267	4	0.5	3	1	0.4	G0	1.402449	-1.015569	2.371906	-4.106893	4.740603	-3.067987	0.829870
268	4	0.5	3	1	0.4	G1	0.243842	0.563424	0.900771	-1.765908	1.452530	-0.869440	0.245489
269	4	0.5	3	1	0.6	G0	1.557104	-1.172949	2.708847	-4.950288	6.142465	-4.213040	1.185212
270	4	0.5	3	1	0.6	G1	0.286319	0.566755	0.818883	-1.581211	1.261642	-0.770743	0.224565
271	4	0.5	3	1	0.8	G0	1.726302	-0.929866	0.379370	1.991462	-3.887896	2.946602	-0.839760
272	4	0.5	3	1	0.8	G1	0.322018	0.886320	-1.261161	4.416832	-7.584188	5.723993	-1.656620
273	4	1	3	2	0.2	G0	0.864248	-0.645272	0.967974	-1.527915	1.123775	-0.530054	0.245014
274	4	1	3	2	0.2	G1	0.117384	0.523199	0.418708	-0.659966	-0.864658	1.091576	-0.226834
275	4	1	3	2	0.4	G0	0.916461	-0.720297	0.881379	-1.084887	0.475648	-0.080998	0.122587
276	4	1	3	2	0.4	G1	0.129874	0.526645	0.317607	-0.398242	-1.200814	1.321215	-0.291951
277	4	1	3	2	0.6	G0	0.978875	-0.798541	0.748365	-0.570062	-0.156208	0.290952	0.033651
278	4	1	3	2	0.6	G1	0.144846	0.533261	0.197175	-0.124641	-1.501769	1.508253	-0.345201
279	4	1	3	2	0.8	G0	1.042042	-0.729579	-0.265310	2.047908	-3.159801	1.903248	-0.291006
280	4	1	3	2	0.8	G1	0.157084	0.627465	-0.414681	1.338731	-3.226914	2.531108	-0.592305

APPENDIX B: AXIAL EXTERNAL FULL-WIDTH CRACK RESULTS

The external axial full-width crack has a constant G value along the crack front to model an infinitely long partial-depth crack, so only the A0 polynomial coefficient value is reported for the non-dimensional geometry factor G results. There are 5 load cases for the full-width crack: G0 is the uniform crack face pressure, G1 is the linear crack face pressure, G2 is the quadratic crack face pressure, G3 is the cubic crack face pressure, and G4 is the quartic (4^{th} order) crack face pressure.

Table 6: Non-Dimensional Geometry Polynomial Coefficient Values for Axial External Full-Width Cracks

Run ID	Y = OD/ID	t/Ri	a/t	Gi	A0
281	2	1	0.2	G0	1.285334
282	2	1	0.2	G1	0.746937
283	2	1	0.2	G2	0.561622
284	2	1	0.2	G3	0.464836
285	2	1	0.2	G4	0.404029
286	2	1	0.4	G0	1.580071
287	2	1	0.4	G1	0.859440
288	2	1	0.4	G2	0.624169
289	2	1	0.4	G3	0.505814
290	2	1	0.4	G4	0.433491
291	2	1	0.6	G0	2.028996
292	2	1	0.6	G1	1.029037
293	2	1	0.6	G2	0.718030
294	2	1	0.6	G3	0.567200
295	2	1	0.6	G4	0.477607
296	2	1	0.8	G0	2.781279
297	2	1	0.8	G1	1.326331
298	2	1	0.8	G2	0.887634
299	2	1	0.8	G3	0.680511
300	2	1	0.8	G4	0.560320
301	2.5	1.5	0.2	G0	1.279295

Run ID	Y = 0D/ID	t/Ri	a/t	Gi	A0
302	2.5	1.5	0.2	G1	0.744331
303	2.5	1.5	0.2	G2	0.560077
304	2.5	1.5	0.2	G3	0.463801
305	2.5	1.5	0.2	G4	0.403292
306	2.5	1.5	0.4	G0	1.538059
307	2.5	1.5	0.4	G1	0.843482
308	2.5	1.5	0.4	G2	0.615370
309	2.5	1.5	0.4	G3	0.500116
310	2.5	1.5	0.4	G4	0.429452
311	2.5	1.5	0.6	G0	1.926480
312	2.5	1.5	0.6	G1	0.991136
313	2.5	1.5	0.6	G2	0.697431
314	2.5	1.5	0.6	G3	0.553958
315	2.5	1.5	0.6	G4	0.468249
316	2.5	1.5	0.8	G0	2.637820
317	2.5	1.5	0.8	G1	1.272779
318	2.5	1.5	0.8	G2	0.858339
319	2.5	1.5	0.8	G3	0.661590
320	2.5	1.5	0.8	G4	0.546900
321	3	2	0.2	G0	1.278540
322	3	2	0.2	G1	0.743950
323	3	2	0.2	G2	0.559845
324	3	2	0.2	G3	0.463650
325	3	2	0.2	G4	0.403192
326	3	2	0.4	G0	1.520006
327	3	2	0.4	G1	0.836545
328	3	2	0.4	G2	0.611498
329	3	2	0.4	G3	0.497580
330	3	2	0.4	G4	0.427634

Run ID	Y = 0D/ID	t/Ri	a/t	Gi	A0
331	3	2	0.6	G0	1.879787
332	3	2	0.6	G1	0.973679
333	3	2	0.6	G2	0.687848
334	3	2	0.6	G3	0.547740
335	3	2	0.6	G4	0.463816
336	3	2	0.8	G0	2.566715
337	3	2	0.8	G1	1.245025
338	3	2	0.8	G2	0.842694
339	3	2	0.8	G3	0.651267
340	3	2	0.8	G4	0.539456
341	3.5	2.5	0.2	G0	1.279489
342	3.5	2.5	0.2	G1	0.744268
343	3.5	2.5	0.2	G2	0.560012
344	3.5	2.5	0.2	G3	0.463760
345	3.5	2.5	0.2	G4	0.403275
346	3.5	2.5	0.4	G0	1.512354
347	3.5	2.5	0.4	G1	0.833585
348	3.5	2.5	0.4	G2	0.609833
349	3.5	2.5	0.4	G3	0.496480
350	3.5	2.5	0.4	G4	0.426839
351	3.5	2.5	0.6	G0	1.856524
352	3.5	2.5	0.6	G1	0.964940
353	3.5	2.5	0.6	G2	0.683035
354	3.5	2.5	0.6	G3	0.544609
355	3.5	2.5	0.6	G4	0.461578
356	3.5	2.5	0.8	G0	2.523619
357	3.5	2.5	0.8	G1	1.227606
358	3.5	2.5	0.8	G2	0.832660
359	3.5	2.5	0.8	G3	0.644550

Run ID	Y = 0D/ID	t/Ri	a/t	Gi	A0
360	3.5	2.5	0.8	G4	0.534560
361	4	3	0.2	G0	1.280960
362	4	3	0.2	G1	0.744803
363	4	3	0.2	G2	0.560300
364	4	3	0.2	G3	0.463947
365	4	3	0.2	G4	0.403410
366	4	3	0.4	G0	1.509651
367	4	3	0.4	G1	0.832519
368	4	3	0.4	G2	0.609219
369	4	3	0.4	G3	0.496062
370	4	3	0.4	G4	0.426529
371	4	3	0.6	G0	1.845007
372	4	3	0.6	G1	0.960657
373	4	3	0.6	G2	0.680705
374	4	3	0.6	G3	0.543105
375	4	3	0.6	G4	0.460501
376	4	3	0.8	G0	2.494990
377	4	3	0.8	G1	1.215762
378	4	3	0.8	G2	0.825746
379	4	3	0.8	G3	0.639874
380	4	3	0.8	G4	0.531117

APPENDIX C: CIRCUMFERENTIAL EXTERNAL SURFACE CRACK RESULTS

Some of the circumferential surface crack cases have an a/c ratio that gives a crack length that is longer than the inside cylinder circumference and are indicated by the "too long" label in the A0 column. There are 4 load cases for the circumferential internal surface cracks: G0 is the uniform crack face pressure, G1 is the linear crack face pressure, G5 is the in-plane bending about the z-axis, and G6 is the out-of-plane bending about the y-axis.

Table 7: Non-Dimensional Geometry Polynomial Coefficient Values for Circumferential External Surface Cracks

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
381	2	0.015625	1	0.03125	0.2	G0	too long						
382	2	0.015625	1	0.03125	0.2	G1	too long						
383	2	0.015625	1	0.03125	0.2	G5	too long						
384	2	0.015625	1	0.03125	0.2	G6	too long						
385	2	0.015625	1	0.03125	0.4	G0	too long						
386	2	0.015625	1	0.03125	0.4	G1	too long						
387	2	0.015625	1	0.03125	0.4	G5	too long						
388	2	0.015625	1	0.03125	0.4	G6	too long						
389	2	0.015625	1	0.03125	0.6	G0	too long						
390	2	0.015625	1	0.03125	0.6	G1	too long						
391	2	0.015625	1	0.03125	0.6	G5	too long						
392	2	0.015625	1	0.03125	0.6	G6	too long						
393	2	0.015625	1	0.03125	0.8	G0	too long						
394	2	0.015625	1	0.03125	0.8	G1	too long						
395	2	0.015625	1	0.03125	0.8	G5	too long						
396	2	0.015625	1	0.03125	0.8	G6	too long						
397	2	0.03125	1	0.0625	0.2	G0	0.247757	2.511528	-3.360426	4.053683	-2.892102	0.661436	0.052018
398	2	0.03125	1	0.0625	0.2	G1	0.008798	0.225308	2.366204	-3.198590	2.661117	-1.932026	0.609342
399	2	0.03125	1	0.0625	0.2	G5	0.011614	-0.241994	2.029974	-0.881880	6.011700	-9.252675	3.503553
400	2	0.03125	1	0.0625	0.2	G6	-0.232852	-2.795556	5.125727	-8.758967	11.713588	-5.102963	0.049416
401	2	0.03125	1	0.0625	0.4	G0	too long						
402	2	0.03125	1	0.0625	0.4	G1	too long						
403	2	0.03125	1	0.0625	0.4	G5	too long						
404	2	0.03125	1	0.0625	0.4	G6	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
405	2	0.03125	1	0.0625	0.6	G0	too long						
406	2	0.03125	1	0.0625	0.6	G1	too long						
407	2	0.03125	1	0.0625	0.6	G5	too long						
408	2	0.03125	1	0.0625	0.6	G6	too long						
409	2	0.03125	1	0.0625	0.8	G0	too long						
410	2	0.03125	1	0.0625	0.8	G1	too long						
411	2	0.03125	1	0.0625	0.8	G5	too long						
412	2	0.03125	1	0.0625	0.8	G6	too long						
413	2	0.0625	1	0.125	0.2	G0	0.409839	0.865110	5.194634	-19.027492	29.748805	-22.618492	6.672461
414	2	0.0625	1	0.125	0.2	G1	0.033588	0.203603	2.494891	-3.766022	3.444365	-2.437597	0.754064
415	2	0.0625	1	0.125	0.2	G5	0.299849	0.842519	1.473313	-3.994471	6.206978	-5.369094	1.698818
416	2	0.0625	1	0.125	0.2	G6	-0.259341	-0.826076	-1.153719	6.919820	-8.326430	4.846767	-1.199104
417	2	0.0625	1	0.125	0.4	G0	0.428252	0.516646	7.678538	-25.031224	40.129628	-31.856532	9.693451
418	2	0.0625	1	0.125	0.4	G1	0.030030	0.191561	2.625685	-3.748247	4.046931	-3.454566	1.149637
419	2	0.0625	1	0.125	0.4	G5	0.003803	0.116787	1.087918	0.676268	5.743929	-10.574666	4.268672
420	2	0.0625	1	0.125	0.4	G6	-0.440682	-0.821534	-4.207636	13.128939	-15.200336	11.636560	-4.095609
421	2	0.0625	1	0.125	0.6	G0	0.345592	0.450129	7.280712	-20.851656	36.762671	-32.234625	10.304173
422	2	0.0625	1	0.125	0.6	G1	-0.002149	0.137029	2.658398	-3.233150	5.036300	-5.516540	1.947561
423	2	0.0625	1	0.125	0.6	G5	-0.357604	-0.764569	-0.166214	3.379018	15.505212	-24.771002	8.762189
424	2	0.0625	1	0.125	0.6	G6	-0.388085	-0.770944	-4.200932	4.711123	-6.678571	16.889332	-9.566777
425	2	0.0625	1	0.125	0.8	G0	too long						
426	2	0.0625	1	0.125	0.8	G1	too long						
427	2	0.0625	1	0.125	0.8	G5	too long						
428	2	0.0625	1	0.125	0.8	G6	too long						
429	2	0.125	1	0.25	0.2	G0	0.642203	-0.591017	9.407568	-26.226017	36.409149	-25.675756	7.218564
430	2	0.125	1	0.25	0.2	G1	0.078493	0.177371	2.330308	-3.464707	2.962435	-1.968066	0.592190
431	2	0.125	1	0.25	0.2	G5	0.597175	-0.189487	5.008770	-11.161526	11.798820	-5.962328	1.009192
432	2	0.125	1	0.25	0.2	G6	-0.205419	0.146389	-2.243008	6.434774	-6.973531	3.500426	-0.657197
433	2	0.125	1	0.25	0.4	G0	0.716921	-0.671910	10.581040	-28.785449	39.785482	-28.136590	7.918208
434	2	0.125	1	0.25	0.4	G1	0.098922	0.182456	2.554512	-3.835006	3.397113	-2.316700	0.702704

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
435	2	0.125	1	0.25	0.4	G5	0.526799	0.056523	3.278685	-5.527425	5.514782	-3.664674	1.036028
436	2	0.125	1	0.25	0.4	G6	-0.409426	0.298796	-4.137143	11.535049	-12.197372	6.092473	-1.179321
437	2	0.125	1	0.25	0.6	G0	0.772005	-0.557388	11.132743	-28.559682	39.226360	-28.451164	8.241971
438	2	0.125	1	0.25	0.6	G1	0.112555	0.231377	2.699926	-3.658122	3.087772	-2.331284	0.776799
439	2	0.125	1	0.25	0.6	G5	0.370724	0.263209	2.357866	-1.490640	1.511231	-2.953498	1.372598
440	2	0.125	1	0.25	0.6	G6	-0.600582	0.397934	-5.699708	15.169907	-15.275139	7.587635	-1.577963
441	2	0.125	1	0.25	0.8	G0	0.780413	-0.173354	10.848313	-23.187026	30.543124	-23.653595	7.382764
442	2	0.125	1	0.25	0.8	G1	0.110836	0.346095	2.730669	-2.344297	1.081502	-1.390964	0.645274
443	2	0.125	1	0.25	0.8	G5	0.128573	0.501983	1.925075	1.527162	1.152650	-7.191812	3.758399
444	2	0.125	1	0.25	0.8	G6	-0.766888	0.369485	-6.610261	14.691242	-9.580139	1.675853	0.221636
445	2	0.25	1	0.5	0.2	G0	0.895170	-0.745369	4.991207	-10.772758	12.818511	-8.330682	2.252615
446	2	0.25	1	0.5	0.2	G1	0.133206	0.368555	1.052939	-0.577089	-0.802806	0.676996	-0.152642
447	2	0.25	1	0.5	0.2	G5	0.857575	-0.657613	3.859075	-5.815975	2.702688	1.091876	-1.012435
448	2	0.25	1	0.5	0.2	G6	-0.130280	0.145817	-0.622182	1.445699	-1.230356	0.432131	-0.038434
449	2	0.25	1	0.5	0.4	G0	0.980306	-0.758597	5.362770	-11.571932	13.258488	-8.163748	2.097123
450	2	0.25	1	0.5	0.4	G1	0.159022	0.366166	1.223342	-1.051170	-0.281608	0.410020	-0.097312
451	2	0.25	1	0.5	0.4	G5	0.900766	-0.541544	3.245547	-6.472677	7.199266	-4.184981	0.897910
452	2	0.25	1	0.5	0.4	G6	-0.259540	0.288675	-1.208585	3.025827	-2.839288	1.112566	-0.116170
453	2	0.25	1	0.5	0.6	G0	1.113120	-0.750256	6.040810	-14.499960	18.926659	-13.396328	3.926543
454	2	0.25	1	0.5	0.6	G1	0.197796	0.371590	1.366604	-1.254617	-0.377874	0.666404	-0.193564
455	2	0.25	1	0.5	0.6	G5	0.935033	-0.559150	2.730464	0.819428	-13.454191	17.775072	-7.146293
456	2	0.25	1	0.5	0.6	G6	-0.387632	0.415403	-1.612910	4.289826	-4.322402	1.886297	-0.264422
457	2	0.25	1	0.5	0.8	G0	1.280489	-0.589927	5.881083	-11.951889	11.510151	-5.933053	1.389378
458	2	0.25	1	0.5	0.8	G1	0.245759	0.428715	1.362974	-0.810840	-1.703275	1.905925	-0.573148
459	2	0.25	1	0.5	0.8	G5	0.970075	-0.060126	1.053885	0.829069	-3.987165	2.842479	-0.452050
460	2	0.25	1	0.5	0.8	G6	-0.518779	0.542636	-2.000866	5.598763	-5.721481	2.349674	-0.246534
461	2	0.5	1	1	0.2	G0	1.216988	-0.884321	2.937341	-6.400540	7.830685	-5.009303	1.330252
462	2	0.5	1	1	0.2	G1	0.187037	0.610481	0.792272	-1.104000	-0.275137	0.812769	-0.307562
463	2	0.5	1	1	0.2	G5	1.182886	-0.835082	2.174227	-3.937059	3.613834	-1.384165	0.105864
464	2	0.5	1	1	0.2	G6	-0.076840	0.117823	-0.376402	1.029985	-1.287340	0.780511	-0.185806

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
465	2	0.5	1	1	0.4	G0	1.267648	-0.867212	2.971680	-6.610152	7.694060	-4.606490	1.177332
466	2	0.5	1	1	0.4	G1	0.199251	0.626331	0.703413	-0.529063	-1.682994	2.074106	-0.680039
467	2	0.5	1	1	0.4	G5	1.203098	-0.824141	1.496227	-0.962097	-2.391329	3.970122	-1.624243
468	2	0.5	1	1	0.4	G6	-0.151378	0.227897	-0.664339	1.889576	-2.430470	1.473029	-0.341702
469	2	0.5	1	1	0.6	G0	1.346752	-0.855553	2.861587	-6.257117	6.610069	-3.566047	0.893401
470	2	0.5	1	1	0.6	G1	0.219786	0.625261	0.725340	-0.507528	-1.851573	2.078951	-0.586744
471	2	0.5	1	1	0.6	G5	1.249657	-0.882507	1.802534	-4.396143	6.497793	-5.146725	1.687030
472	2	0.5	1	1	0.6	G6	-0.223726	0.332083	-0.837231	2.461713	-3.241110	1.945461	-0.434041
473	2	0.5	1	1	0.8	G0	1.452767	-0.837935	2.467001	-4.490136	2.796140	-0.426842	0.067437
474	2	0.5	1	1	0.8	G1	0.244401	0.631729	0.656894	0.004686	-2.970157	2.823204	-0.694572
475	2	0.5	1	1	0.8	G5	1.299952	-0.969162	2.328826	-6.998699	10.534412	-7.746337	2.285366
476	2	0.5	1	1	0.8	G6	-0.295422	0.443427	-0.971428	2.972785	-4.060981	2.453585	-0.538396
477	2	1	1	2	0.2	G0	0.820072	-0.533658	0.890602	-1.724605	1.638909	-1.139743	0.518042
478	2	1	1	2	0.2	G1	0.103873	0.548918	0.341865	-0.367842	-1.318218	1.260911	-0.190080
479	2	1	1	2	0.2	G5	0.795584	-0.521223	0.438534	-0.374874	-0.372261	0.479771	-0.032278
480	2	1	1	2	0.2	G6	-0.023871	0.050547	-0.194357	0.575648	-0.822423	0.595134	-0.176444
481	2	1	1	2	0.4	G0	0.829623	-0.557437	1.072062	-2.500268	3.120638	-2.572894	1.056904
482	2	1	1	2	0.4	G1	0.104690	0.534923	0.453443	-0.766164	-0.501827	0.344661	0.194263
483	2	1	1	2	0.4	G5	0.795840	-0.602703	0.590105	-1.049967	1.040653	-0.827483	0.415867
484	2	1	1	2	0.4	G6	-0.046402	0.091402	-0.303591	0.907021	-1.303663	0.926164	-0.265611
485	2	1	1	2	0.6	G0	0.843470	-0.577584	1.166860	-3.086424	4.458407	-4.027290	1.641687
486	2	1	1	2	0.6	G1	0.106668	0.514932	0.595145	-1.334138	0.722947	-1.011313	0.747720
487	2	1	1	2	0.6	G5	0.799070	-0.667599	0.598364	-1.332764	1.868519	-1.681591	0.723190
488	2	1	1	2	0.6	G6	-0.068334	0.134480	-0.393677	1.198434	-1.790210	1.302523	-0.377049
489	2	1	1	2	0.8	G0	0.862215	-0.614692	1.329916	-3.928620	6.255639	-5.888609	2.365042
490	2	1	1	2	0.8	G1	0.109085	0.486801	0.815164	-2.237327	2.620300	-2.994293	1.516129
491	2	1	1	2	0.8	G5	0.807039	-0.741798	0.593287	-1.506023	2.410195	-2.234824	0.921269
492	2	1	1	2	0.8	G6	-0.089734	0.179142	-0.452674	1.393734	-2.171409	1.624931	-0.477047
493	2.5	0.015625	1.5	0.03125	0.2	G0	too long						
494	2.5	0.015625	1.5	0.03125	0.2	G1	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
495	2.5	0.015625	1.5	0.03125	0.2	G5	too long						
496	2.5	0.015625	1.5	0.03125	0.2	G6	too long						
497	2.5	0.015625	1.5	0.03125	0.4	G0	too long						
498	2.5	0.015625	1.5	0.03125	0.4	G1	too long						
499	2.5	0.015625	1.5	0.03125	0.4	G5	too long						
500	2.5	0.015625	1.5	0.03125	0.4	G6	too long						
501	2.5	0.015625	1.5	0.03125	0.6	G0	too long						
502	2.5	0.015625	1.5	0.03125	0.6	G1	too long						
503	2.5	0.015625	1.5	0.03125	0.6	G5	too long						
504	2.5	0.015625	1.5	0.03125	0.6	G6	too long						
505	2.5	0.015625	1.5	0.03125	0.8	G0	too long						
506	2.5	0.015625	1.5	0.03125	0.8	G1	too long						
507	2.5	0.015625	1.5	0.03125	0.8	G5	too long						
508	2.5	0.015625	1.5	0.03125	0.8	G6	too long						
509	2.5	0.03125	1.5	0.0625	0.2	G0	0.244309	2.466376	-3.157444	3.645765	-2.264582	0.132711	0.218572
510	2.5	0.03125	1.5	0.0625	0.2	G1	0.007399	0.212887	2.387620	-3.171574	2.627572	-1.931601	0.612685
511	2.5	0.03125	1.5	0.0625	0.2	G5	-0.067669	-1.030374	3.259752	-2.287097	9.982790	-13.492740	4.806477
512	2.5	0.03125	1.5	0.0625	0.2	G6	-0.221174	-2.673058	4.713841	-10.105322	13.492672	-4.184595	-1.024783
513	2.5	0.03125	1.5	0.0625	0.4	G0	too long						
514	2.5	0.03125	1.5	0.0625	0.4	G1	too long						
515	2.5	0.03125	1.5	0.0625	0.4	G5	too long						
516	2.5	0.03125	1.5	0.0625	0.4	G6	too long						
517	2.5	0.03125	1.5	0.0625	0.6	G0	too long						
518	2.5	0.03125	1.5	0.0625	0.6	G1	too long						
519	2.5	0.03125	1.5	0.0625	0.6	G5	too long						
520	2.5	0.03125	1.5	0.0625	0.6	G6	too long						
521	2.5	0.03125	1.5	0.0625	0.8	G0	too long						
522	2.5	0.03125	1.5	0.0625	0.8	G1	too long						
523	2.5	0.03125	1.5	0.0625	0.8	G5	too long						
524	2.5	0.03125	1.5	0.0625	0.8	G6	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
525	2.5	0.0625	1.5	0.125	0.2	G0	0.406965	0.934128	4.697086	-17.361149	27.237992	-20.847359	6.191749
526	2.5	0.0625	1.5	0.125	0.2	G1	0.033028	0.203449	2.501921	-3.755076	3.443494	-2.461267	0.766651
527	2.5	0.0625	1.5	0.125	0.2	G5	0.261607	0.448914	3.087923	-7.070942	9.411067	-6.757007	1.768642
528	2.5	0.0625	1.5	0.125	0.2	G6	-0.299372	-0.931483	-1.454120	8.187521	-10.115515	6.349177	-1.734557
529	2.5	0.0625	1.5	0.125	0.4	G0	0.404270	0.491419	7.607231	-24.366627	39.524989	-31.792549	9.738286
530	2.5	0.0625	1.5	0.125	0.4	G1	0.021522	0.185848	2.537753	-3.281802	3.464665	-3.143065	1.074491
531	2.5	0.0625	1.5	0.125	0.4	G5	-0.138867	-0.074904	-0.824725	8.001586	-2.888848	-5.843260	3.077302
532	2.5	0.0625	1.5	0.125	0.4	G6	-0.435281	-0.824346	-4.361047	11.400758	-12.679390	11.797668	-4.899369
533	2.5	0.0625	1.5	0.125	0.6	G0	0.252232	0.360003	6.732286	-20.285509	40.250788	-37.078281	11.923697
534	2.5	0.0625	1.5	0.125	0.6	G1	0.062757	-1.360254	10.319252	-23.701078	34.942503	-27.251486	8.060240
535	2.5	0.0625	1.5	0.125	0.6	G5	-0.538895	-1.123870	-1.516707	2.967728	25.407465	-34.543476	10.974648
536	2.5	0.0625	1.5	0.125	0.6	G6	-0.233752	-0.521150	-3.812601	-1.530481	-5.157112	27.353115	-16.105408
537	2.5	0.0625	1.5	0.125	0.8	G0	too long						
538	2.5	0.0625	1.5	0.125	0.8	G1	too long						
539	2.5	0.0625	1.5	0.125	0.8	G5	too long						
540	2.5	0.0625	1.5	0.125	0.8	G6	too long						
541	2.5	0.125	1.5	0.25	0.2	G0	0.643234	-0.519794	8.840914	-24.342219	33.579698	-23.696622	6.691108
542	2.5	0.125	1.5	0.25	0.2	G1	0.078321	0.189997	2.265215	-3.257390	2.657137	-1.758057	0.536719
543	2.5	0.125	1.5	0.25	0.2	G5	0.572518	-0.263719	6.141599	-15.135805	17.718445	-9.894333	1.956311
544	2.5	0.125	1.5	0.25	0.2	G6	-0.244765	0.152225	-2.449150	6.917711	-7.153994	3.327685	-0.547192
545	2.5	0.125	1.5	0.25	0.4	G0	0.711073	-0.493332	9.505373	-25.346688	34.719186	-24.623729	6.978427
546	2.5	0.125	1.5	0.25	0.4	G1	0.097626	0.196166	2.554600	-3.797668	3.353763	-2.318730	0.712440
547	2.5	0.125	1.5	0.25	0.4	G5	0.469463	-0.419338	6.676024	-14.716328	17.504519	-10.858870	2.556001
548	2.5	0.125	1.5	0.25	0.4	G6	-0.471585	0.289235	-4.421912	12.292908	-12.811850	6.407745	-1.281585
549	2.5	0.125	1.5	0.25	0.6	G0	0.738419	-0.349896	10.620221	-27.271195	38.655595	-29.198179	8.742946
550	2.5	0.125	1.5	0.25	0.6	G1	0.102578	0.272682	2.618383	-3.217368	2.519548	-2.075710	0.742662
551	2.5	0.125	1.5	0.25	0.6	G5	0.240392	0.025666	2.388526	2.640792	-8.215843	6.151896	-1.793005
552	2.5	0.125	1.5	0.25	0.6	G6	-0.662228	0.328048	-5.941392	15.545000	-15.135962	7.548923	-1.680522
553	2.5	0.125	1.5	0.25	0.8	G0	0.633272	0.191366	9.635282	-17.860726	24.478675	-21.439248	7.261653
554	2.5	0.125	1.5	0.25	0.8	G1	0.062674	0.463875	2.260488	-0.191016	-1.688785	-0.031327	0.419193

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
555	2.5	0.125	1.5	0.25	0.8	G5	-0.149711	0.897143	-2.080685	16.226423	-19.459345	6.057525	0.368673
556	2.5	0.125	1.5	0.25	0.8	G6	-0.831514	0.260178	-6.970555	13.466600	-5.018823	-1.991211	1.085739
557	2.5	0.25	1.5	0.5	0.2	G0	0.896742	-0.723168	4.970579	-10.820133	12.922809	-8.406209	2.273033
558	2.5	0.25	1.5	0.5	0.2	G1	0.133509	0.378231	1.025672	-0.531811	-0.833924	0.667254	-0.138491
559	2.5	0.25	1.5	0.5	0.2	G5	0.853533	-0.568458	3.141223	-4.171455	1.482985	0.950411	-0.669691
560	2.5	0.25	1.5	0.5	0.2	G6	-0.155570	0.168085	-0.709073	1.665531	-1.406535	0.468225	-0.028228
561	2.5	0.25	1.5	0.5	0.4	G0	0.983478	-0.637437	4.745461	-9.947368	11.204734	-7.005326	1.877543
562	2.5	0.25	1.5	0.5	0.4	G1	0.159305	0.391583	1.148714	-0.834729	-0.661140	0.712346	-0.183603
563	2.5	0.25	1.5	0.5	0.4	G5	0.873224	-0.661696	4.923891	-11.791861	13.948271	-7.710853	1.444908
564	2.5	0.25	1.5	0.5	0.4	G6	-0.307576	0.323756	-1.289001	3.259921	-3.000563	1.102352	-0.085449
565	2.5	0.25	1.5	0.5	0.6	G0	1.120359	-0.671356	6.499562	-16.370106	21.575812	-15.059969	4.311617
566	2.5	0.25	1.5	0.5	0.6	G1	0.199440	0.411780	1.331732	-1.172688	-0.592782	0.844440	-0.234067
567	2.5	0.25	1.5	0.5	0.6	G5	0.888202	-0.120639	-0.400064	9.105764	-22.074089	20.388943	-6.698464
568	2.5	0.25	1.5	0.5	0.6	G6	-0.453128	0.470675	-1.847450	5.224087	-5.613451	2.650393	-0.426860
569	2.5	0.25	1.5	0.5	0.8	G0	1.298817	-0.183319	4.438347	-7.676958	5.059233	-1.594927	0.356679
570	2.5	0.25	1.5	0.5	0.8	G1	0.251006	0.507020	1.258388	-0.380135	-2.599679	2.550437	-0.704912
571	2.5	0.25	1.5	0.5	0.8	G5	0.896163	-0.379211	4.951513	-9.579768	7.326591	-1.864988	-0.156262
572	2.5	0.25	1.5	0.5	0.8	G6	-0.597760	0.573901	-1.980767	5.831218	-5.876313	2.158679	-0.105614
573	2.5	0.5	1.5	1	0.2	G0	1.217809	-0.860622	2.868641	-6.259973	7.555429	-4.750153	1.246484
574	2.5	0.5	1.5	1	0.2	G1	0.186734	0.617158	0.770903	-0.999736	-0.528553	1.044189	-0.377516
575	2.5	0.5	1.5	1	0.2	G5	1.176882	-0.765000	1.467445	-1.146847	-1.628867	3.199765	-1.399288
576	2.5	0.5	1.5	1	0.2	G6	-0.091576	0.132498	-0.394281	1.083396	-1.335176	0.786422	-0.179343
577	2.5	0.5	1.5	1	0.4	G0	1.268002	-0.814545	2.844085	-6.329234	7.105454	-4.079007	1.023942
578	2.5	0.5	1.5	1	0.4	G1	0.198158	0.647266	0.620156	-0.243836	-2.191515	2.425091	-0.750887
579	2.5	0.5	1.5	1	0.4	G5	1.191112	-0.718965	0.814378	0.251373	-2.760564	3.096456	-1.037188
580	2.5	0.5	1.5	1	0.4	G6	-0.180045	0.264250	-0.715443	2.064619	-2.666524	1.595044	-0.359277
581	2.5	0.5	1.5	1	0.6	G0	1.347624	-0.764540	2.703343	-5.984825	6.014451	-3.113648	0.816716
582	2.5	0.5	1.5	1	0.6	G1	0.218449	0.644734	0.706644	-0.379585	-2.204115	2.303890	-0.599527
583	2.5	0.5	1.5	1	0.6	G5	1.228937	-0.871353	1.917320	-5.234064	7.697250	-5.674633	1.693182
584	2.5	0.5	1.5	1	0.6	G6	-0.265435	0.391695	-0.909937	2.769403	-3.749861	2.272171	-0.504897

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
585	2.5	0.5	1.5	1	0.8	G0	1.458000	-0.627682	1.659737	-2.665548	0.644863	0.344716	0.187250
586	2.5	0.5	1.5	1	0.8	G1	0.243250	0.678287	0.492849	0.473512	-3.551262	2.838634	-0.505125
587	2.5	0.5	1.5	1	0.8	G5	1.260266	-0.967693	2.795534	-7.534121	8.183348	-3.364214	0.284941
588	2.5	0.5	1.5	1	0.8	G6	-0.347949	0.519695	-0.973242	3.101215	-4.364920	2.624754	-0.555997
589	2.5	1	1.5	2	0.2	G0	0.819435	-0.528462	0.879297	-1.744264	1.737595	-1.291108	0.591296
590	2.5	1	1.5	2	0.2	G1	0.103374	0.547820	0.357172	-0.431293	-1.169658	1.075091	-0.107267
591	2.5	1	1.5	2	0.2	G5	0.793164	-0.529666	0.419197	-0.322203	-0.432511	0.507169	-0.034484
592	2.5	1	1.5	2	0.2	G6	-0.028315	0.056066	-0.202357	0.599888	-0.849730	0.604994	-0.176348
593	2.5	1	1.5	2	0.4	G0	0.828020	-0.549839	1.083638	-2.692100	3.618497	-3.147098	1.294347
594	2.5	1	1.5	2	0.4	G1	0.103627	0.530280	0.507724	-1.000148	0.013483	-0.229694	0.429132
595	2.5	1	1.5	2	0.4	G5	0.790611	-0.617111	0.574791	-1.112962	1.291431	-1.114043	0.525202
596	2.5	1	1.5	2	0.4	G6	-0.055114	0.106023	-0.329168	0.993856	-1.448051	1.033471	-0.295749
597	2.5	1	1.5	2	0.6	G0	0.840949	-0.571295	1.252843	-3.683858	5.798729	-5.405785	2.164704
598	2.5	1	1.5	2	0.6	G1	0.105141	0.502777	0.727283	-1.907060	1.927853	-2.257699	1.226569
599	2.5	1	1.5	2	0.6	G5	0.790837	-0.687727	0.631696	-1.732733	2.835524	-2.602511	1.036609
600	2.5	1	1.5	2	0.6	G6	-0.081083	0.159278	-0.424910	1.307167	-2.001868	1.476853	-0.429328
601	2.5	1	1.5	2	0.8	G0	0.859385	-0.613837	1.532800	-5.125289	8.758127	-8.288419	3.221896
602	2.5	1	1.5	2	0.8	G1	0.107398	0.462912	1.060175	-3.309948	4.804572	-5.139206	2.301687
603	2.5	1	1.5	2	0.8	G5	0.794138	-0.734263	0.388965	-1.393586	2.920660	-3.001593	1.228697
604	2.5	1	1.5	2	0.8	G6	-0.106325	0.214844	-0.476064	1.481993	-2.403679	1.841543	-0.545415
605	3	0.015625	2	0.03125	0.2	G0	too long						
606	3	0.015625	2	0.03125	0.2	G1	too long						
607	3	0.015625	2	0.03125	0.2	G5	too long						
608	3	0.015625	2	0.03125	0.2	G6	too long						
609	3	0.015625	2	0.03125	0.4	G0	too long						
610	3	0.015625	2	0.03125	0.4	G1	too long						
611	3	0.015625	2	0.03125	0.4	G5	too long						
612	3	0.015625	2	0.03125	0.4	G6	too long						
613	3	0.015625	2	0.03125	0.6	G0	too long						
614	3	0.015625	2	0.03125	0.6	G1	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
615	3	0.015625	2	0.03125	0.6	G5	too long						
616	3	0.015625	2	0.03125	0.6	G6	too long						
617	3	0.015625	2	0.03125	0.8	G0	too long						
618	3	0.015625	2	0.03125	0.8	G1	too long						
619	3	0.015625	2	0.03125	0.8	G5	too long						
620	3	0.015625	2	0.03125	0.8	G6	too long						
621	3	0.03125	2	0.0625	0.2	G0	0.237379	2.495049	-3.487719	4.840795	-4.040595	1.385195	-0.134425
622	3	0.03125	2	0.0625	0.2	G1	0.005939	0.199326	2.416546	-3.185959	2.678518	-2.004195	0.638991
623	3	0.03125	2	0.0625	0.2	G5	-0.100838	-1.852411	6.009866	-9.102339	21.088995	-21.909464	7.032883
624	3	0.03125	2	0.0625	0.2	G6	-0.197675	-2.535124	4.628582	-11.953745	15.463749	-3.422560	-1.986421
625	3	0.03125	2	0.0625	0.4	G0	too long						
626	3	0.03125	2	0.0625	0.4	G1	too long						
627	3	0.03125	2	0.0625	0.4	G5	too long						
628	3	0.03125	2	0.0625	0.4	G6	too long						
629	3	0.03125	2	0.0625	0.6	G0	too long						
630	3	0.03125	2	0.0625	0.6	G1	too long						
631	3	0.03125	2	0.0625	0.6	G5	too long						
632	3	0.03125	2	0.0625	0.6	G6	too long						
633	3	0.03125	2	0.0625	0.8	G0	too long						
634	3	0.03125	2	0.0625	0.8	G1	too long						
635	3	0.03125	2	0.0625	0.8	G5	too long						
636	3	0.03125	2	0.0625	0.8	G6	too long						
637	3	0.0625	2	0.125	0.2	G0	0.403671	0.953985	4.788497	-17.979409	28.647710	-22.195487	6.652757
638	3	0.0625	2	0.125	0.2	G1	0.032467	0.208078	2.476581	-3.654324	3.305165	-2.378477	0.747152
639	3	0.0625	2	0.125	0.2	G5	0.237826	0.303551	2.607992	-3.731791	3.674248	-2.537343	0.594392
640	3	0.0625	2	0.125	0.2	G6	-0.319569	-1.040926	-1.322684	7.857416	-9.379192	5.833343	-1.626588
641	3	0.0625	2	0.125	0.4	G0	0.375386	0.552242	6.880293	-21.777542	36.104206	-29.679867	9.193728
642	3	0.0625	2	0.125	0.4	G1	0.012627	0.176960	2.461409	-2.884253	3.027434	-2.957622	1.038923
643	3	0.0625	2	0.125	0.4	G5	-0.211156	-0.672257	0.896684	4.024819	4.244158	-11.590322	4.614143
644	3	0.0625	2	0.125	0.4	G6	-0.411726	-0.886423	-3.789361	7.919580	-8.022952	10.383710	-5.194411

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
645	3	0.0625	2	0.125	0.6	G0	too long						
646	3	0.0625	2	0.125	0.6	G1	too long						
647	3	0.0625	2	0.125	0.6	G5	too long						
648	3	0.0625	2	0.125	0.6	G6	too long						
649	3	0.0625	2	0.125	0.8	G0	too long						
650	3	0.0625	2	0.125	0.8	G1	too long						
651	3	0.0625	2	0.125	0.8	G5	too long						
652	3	0.0625	2	0.125	0.8	G6	too long						
653	3	0.125	2	0.25	0.2	G0	0.644901	-0.520151	8.984654	-25.081396	35.169072	-25.200078	7.208586
654	3	0.125	2	0.25	0.2	G1	0.078472	0.188951	2.315210	-3.451959	3.008918	-2.057087	0.632547
655	3	0.125	2	0.25	0.2	G5	0.552343	-0.215641	5.869658	-13.727943	14.498444	-6.690732	0.806327
656	3	0.125	2	0.25	0.2	G6	-0.270114	0.162003	-2.660832	7.560643	-7.900853	3.771564	-0.659927
657	3	0.125	2	0.25	0.4	G0	0.708230	-0.481973	10.001095	-27.536860	38.979180	-28.396869	8.215713
658	3	0.125	2	0.25	0.4	G1	0.096826	0.213382	2.508375	-3.615957	3.086004	-2.148692	0.670914
659	3	0.125	2	0.25	0.4	G5	0.425687	-0.196560	3.679836	-2.903585	-2.272016	4.424191	-1.943944
660	3	0.125	2	0.25	0.4	G6	-0.507491	0.288696	-4.805064	13.631496	-14.749922	7.891444	-1.746237
661	3	0.125	2	0.25	0.6	G0	0.710168	-0.249490	10.021922	-23.913354	32.613019	-24.387461	7.258058
662	3	0.125	2	0.25	0.6	G1	0.091842	0.310703	2.490269	-2.577811	1.586499	-1.510822	0.610236
663	3	0.125	2	0.25	0.6	G5	0.101299	0.432677	1.167085	2.398617	-1.100307	-3.739478	2.198523
664	3	0.125	2	0.25	0.6	G6	-0.702710	0.339768	-6.231491	15.263008	-13.173098	5.558127	-1.051481
665	3	0.125	2	0.25	0.8	G0	0.460782	0.650182	7.368339	-9.320670	13.574515	-15.734917	6.187175
666	3	0.125	2	0.25	0.8	G1	0.007358	0.577315	1.725194	2.093667	-4.591023	1.377486	0.197229
667	3	0.125	2	0.25	0.8	G5	-0.332955	0.535391	-0.724945	14.890208	-17.525185	4.069720	0.998219
668	3	0.125	2	0.25	0.8	G6	-0.881593	0.084862	-6.910293	11.487902	-0.180830	-5.296292	1.695338
669	3	0.25	2	0.5	0.2	G0	0.898006	-0.708281	4.964654	-10.874859	13.021276	-8.474461	2.291230
670	3	0.25	2	0.5	0.2	G1	0.133920	0.380123	1.053640	-0.670154	-0.573202	0.441053	-0.063929
671	3	0.25	2	0.5	0.2	G5	0.851484	-0.537869	2.953335	-4.069142	2.074902	0.034983	-0.294659
672	3	0.25	2	0.5	0.2	G6	-0.172305	0.184486	-0.783857	1.884721	-1.660577	0.608594	-0.058619
673	3	0.25	2	0.5	0.4	G0	0.988868	-0.611897	4.935197	-11.143346	13.756121	-9.376212	2.686712
674	3	0.25	2	0.5	0.4	G1	0.160419	0.397915	1.204781	-1.061381	-0.305994	0.438966	-0.098551

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
675	3	0.25	2	0.5	0.4	G5	0.850924	-0.565679	4.158315	-7.731637	4.700313	1.365704	-1.761789
676	3	0.25	2	0.5	0.4	G6	-0.338468	0.348927	-1.372766	3.555641	-3.367668	1.304910	-0.127128
677	3	0.25	2	0.5	0.6	G0	1.133755	-0.538422	5.653084	-12.581715	13.923038	-8.176993	2.032520
678	3	0.25	2	0.5	0.6	G1	0.202815	0.440499	1.261605	-0.843488	-1.316754	1.484798	-0.431488
679	3	0.25	2	0.5	0.6	G5	0.849968	-0.069906	1.343760	-1.184919	0.118486	-0.368374	0.396096
680	3	0.25	2	0.5	0.6	G6	-0.495592	0.511954	-1.951133	5.498686	-5.707081	2.434968	-0.287480
681	3	0.25	2	0.5	0.8	G0	1.320717	-0.043912	5.156075	-10.916628	10.972936	-6.903365	2.205768
682	3	0.25	2	0.5	0.8	G1	0.256591	0.573514	1.131253	0.118589	-3.508726	3.135079	-0.802789
683	3	0.25	2	0.5	0.8	G5	0.848206	0.098670	0.632586	7.318856	-21.969851	21.288313	-7.012517
684	3	0.25	2	0.5	0.8	G6	-0.646440	0.597990	-2.114737	6.617607	-7.002899	2.750062	-0.198201
685	3	0.5	2	1	0.2	G0	1.218534	-0.845119	2.824572	-6.168247	7.371567	-4.577082	1.191116
686	3	0.5	2	1	0.2	G1	0.186586	0.621632	0.755873	-0.926404	-0.703472	1.201403	-0.424248
687	3	0.5	2	1	0.2	G5	1.174192	-0.783461	1.672492	-1.988049	-0.116965	1.913706	-0.977747
688	3	0.5	2	1	0.2	G6	-0.101362	0.143627	-0.417102	1.162574	-1.448288	0.860074	-0.197590
689	3	0.5	2	1	0.4	G0	1.269512	-0.779909	2.761399	-6.144328	6.715548	-3.739290	0.930554
690	3	0.5	2	1	0.4	G1	0.198046	0.653032	0.635397	-0.306066	-2.101713	2.310490	-0.689329
691	3	0.5	2	1	0.4	G5	1.186510	-0.753833	1.314848	-2.380365	2.726539	-1.952217	0.673764
692	3	0.5	2	1	0.4	G6	-0.198910	0.287802	-0.735748	2.136243	-2.752614	1.617861	-0.351996
693	3	0.5	2	1	0.6	G0	1.352910	-0.693363	2.345919	-4.703960	3.626191	-1.195959	0.277190
694	3	0.5	2	1	0.6	G1	0.218422	0.666409	0.594177	0.078894	-3.054549	2.911874	-0.734521
695	3	0.5	2	1	0.6	G5	1.210770	-0.818645	1.970500	-6.057953	9.050650	-6.450074	1.814528
696	3	0.5	2	1	0.6	G6	-0.292769	0.431906	-0.928747	2.839062	-3.827600	2.252012	-0.470683
697	3	0.5	2	1	0.8	G0	1.469948	-0.576148	1.929694	-4.483673	4.545563	-3.595386	1.687504
698	3	0.5	2	1	0.8	G1	0.244554	0.685341	0.591036	-0.015629	-2.440050	1.505846	0.077572
699	3	0.5	2	1	0.8	G5	1.234619	-0.846149	2.011291	-3.957121	0.238591	4.254626	-2.327353
700	3	0.5	2	1	0.8	G6	-0.381574	0.574578	-0.995862	3.309023	-4.842983	2.989497	-0.649145
701	3	1	2	2	0.2	G0	0.819045	-0.525260	0.873864	-1.766595	1.822345	-1.410010	0.646434
702	3	1	2	2	0.2	G1	0.103057	0.546891	0.369004	-0.480904	-1.055277	0.936446	-0.046843
703	3	1	2	2	0.2	G5	0.791409	-0.533255	0.398655	-0.291840	-0.415713	0.443800	-0.000710
704	3	1	2	2	0.2	G6	-0.031259	0.059835	-0.207486	0.615621	-0.868503	0.612810	-0.176846

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
705	3	1	2	2	0.4	G0	0.827253	-0.546276	1.102491	-2.867149	4.042184	-3.612309	1.480127
706	3	1	2	2	0.4	G1	0.103021	0.526251	0.551630	-1.189796	0.424505	-0.674787	0.606846
707	3	1	2	2	0.4	G5	0.787293	-0.629238	0.597469	-1.299976	1.736295	-1.546495	0.676465
708	3	1	2	2	0.4	G6	-0.060870	0.116382	-0.347756	1.058887	-1.562290	1.123060	-0.322185
709	3	1	2	2	0.6	G0	0.840071	-0.570913	1.337019	-4.194349	6.899480	-6.498881	2.567444
710	3	1	2	2	0.6	G1	0.104359	0.493291	0.824310	-2.331766	2.818589	-3.168079	1.571706
711	3	1	2	2	0.6	G5	0.786357	-0.707723	0.668295	-2.023112	3.528411	-3.273780	1.270016
712	3	1	2	2	0.6	G6	-0.089477	0.176372	-0.441043	1.363766	-2.124745	1.582744	-0.461542
713	3	1	2	2	0.8	G0	0.858904	-0.619034	1.702378	-6.057041	10.627234	-10.006984	3.812187
714	3	1	2	2	0.8	G1	0.106637	0.441967	1.261125	-4.158405	6.458577	-6.694246	2.850570
715	3	1	2	2	0.8	G5	0.786106	-0.746891	0.397980	-1.790126	3.920114	-3.899015	1.504538
716	3	1	2	2	0.8	G6	-0.117268	0.242207	-0.510527	1.623058	-2.734187	2.149863	-0.646318
717	3.5	0.015625	2.5	0.03125	0.2	G0	too long						
718	3.5	0.015625	2.5	0.03125	0.2	G1	too long						
719	3.5	0.015625	2.5	0.03125	0.2	G5	too long						
720	3.5	0.015625	2.5	0.03125	0.2	G6	too long						
721	3.5	0.015625	2.5	0.03125	0.4	G0	too long						
722	3.5	0.015625	2.5	0.03125	0.4	G1	too long						
723	3.5	0.015625	2.5	0.03125	0.4	G5	too long						
724	3.5	0.015625	2.5	0.03125	0.4	G6	too long						
725	3.5	0.015625	2.5	0.03125	0.6	G0	too long						
726	3.5	0.015625	2.5	0.03125	0.6	G1	too long						
727	3.5	0.015625	2.5	0.03125	0.6	G5	too long						
728	3.5	0.015625	2.5	0.03125	0.6	G6	too long						
729	3.5	0.015625	2.5	0.03125	0.8	G0	too long						
730	3.5	0.015625	2.5	0.03125	0.8	G1	too long						
731	3.5	0.015625	2.5	0.03125	0.8	G5	too long						
732	3.5	0.015625	2.5	0.03125	0.8	G6	too long						
733	3.5	0.03125	2.5	0.0625	0.2	G0	0.236934	2.397311	-2.975954	3.478131	-1.954255	-0.211817	0.333398
734	3.5	0.03125	2.5	0.0625	0.2	G1	0.004615	0.187374	2.439765	-3.202290	2.742030	-2.086810	0.667886

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
735	3.5	0.03125	2.5	0.0625	0.2	G5	-0.149468	-1.880229	4.937598	-6.882432	20.785297	-23.236427	7.591803
736	3.5	0.03125	2.5	0.0625	0.2	G6	-0.179772	-2.297543	4.052476	-12.288204	15.596411	-1.946504	-2.940197
737	3.5	0.03125	2.5	0.0625	0.4	G0	too long						
738	3.5	0.03125	2.5	0.0625	0.4	G1	too long						
739	3.5	0.03125	2.5	0.0625	0.4	G5	too long						
740	3.5	0.03125	2.5	0.0625	0.4	G6	too long						
741	3.5	0.03125	2.5	0.0625	0.6	G0	too long						
742	3.5	0.03125	2.5	0.0625	0.6	G1	too long						
743	3.5	0.03125	2.5	0.0625	0.6	G5	too long						
744	3.5	0.03125	2.5	0.0625	0.6	G6	too long						
745	3.5	0.03125	2.5	0.0625	0.8	G0	too long						
746	3.5	0.03125	2.5	0.0625	0.8	G1	too long						
747	3.5	0.03125	2.5	0.0625	0.8	G5	too long						
748	3.5	0.03125	2.5	0.0625	0.8	G6	too long						
749	3.5	0.0625	2.5	0.125	0.2	G0	0.407435	0.864218	5.363353	-19.480826	30.678020	-23.562820	7.012419
750	3.5	0.0625	2.5	0.125	0.2	G1	0.032373	0.204850	2.497989	-3.687878	3.354679	-2.423736	0.762053
751	3.5	0.0625	2.5	0.125	0.2	G5	0.195170	0.572974	0.609996	1.540704	-2.185503	0.211700	0.204128
752	3.5	0.0625	2.5	0.125	0.2	G6	-0.337159	-1.019014	-1.778750	9.037863	-10.796230	6.825377	-1.930287
753	3.5	0.0625	2.5	0.125	0.4	G0	0.356604	0.461819	7.110410	-21.994654	36.674930	-30.314911	9.387500
754	3.5	0.0625	2.5	0.125	0.4	G1	0.004506	0.170241	2.378834	-2.515485	2.647775	-2.808888	1.011679
755	3.5	0.0625	2.5	0.125	0.4	G5	-0.296263	-0.392805	-1.872826	10.889576	-2.249825	-8.978096	4.211162
756	3.5	0.0625	2.5	0.125	0.4	G6	-0.394221	-0.753066	-4.432755	8.418486	-9.547796	13.422059	-6.715129
757	3.5	0.0625	2.5	0.125	0.6	G0	too long						
758	3.5	0.0625	2.5	0.125	0.6	G1	too long						
759	3.5	0.0625	2.5	0.125	0.6	G5	too long						
760	3.5	0.0625	2.5	0.125	0.6	G6	too long						
761	3.5	0.0625	2.5	0.125	0.8	G0	too long						
762	3.5	0.0625	2.5	0.125	0.8	G1	too long						
763	3.5	0.0625	2.5	0.125	0.8	G5	too long						
764	3.5	0.0625	2.5	0.125	0.8	G6	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
765	3.5	0.125	2.5	0.25	0.2	G0	0.646174	-0.525424	9.143771	-25.765392	36.470175	-26.329628	7.573289
766	3.5	0.125	2.5	0.25	0.2	G1	0.078937	0.186120	2.344789	-3.517002	3.077901	-2.091296	0.638082
767	3.5	0.125	2.5	0.25	0.2	G5	0.548920	-0.308881	5.989992	-12.676971	11.245064	-3.316572	-0.390119
768	3.5	0.125	2.5	0.25	0.2	G6	-0.287623	0.164338	-2.772689	7.877572	-8.189482	3.886825	-0.676411
769	3.5	0.125	2.5	0.25	0.4	G0	0.712553	-0.562743	10.642420	-29.095698	40.939718	-29.625359	8.509887
770	3.5	0.125	2.5	0.25	0.4	G1	0.096786	0.215408	2.542044	-3.657096	3.127104	-2.186810	0.684258
771	3.5	0.125	2.5	0.25	0.4	G5	0.368824	0.244610	1.182995	2.753019	-7.324268	5.592899	-1.598399
772	3.5	0.125	2.5	0.25	0.4	G6	-0.535174	0.339161	-5.208002	14.399722	-15.120214	7.738258	-1.610395
773	3.5	0.125	2.5	0.25	0.6	G0	0.673012	-0.052397	9.024902	-20.384584	27.657097	-21.252682	6.484488
774	3.5	0.125	2.5	0.25	0.6	G1	0.080887	0.339128	2.389818	-2.030676	0.788381	-1.037417	0.502752
775	3.5	0.125	2.5	0.25	0.6	G5	0.039407	-0.015935	3.486568	-2.293297	4.009482	-6.367896	2.615585
776	3.5	0.125	2.5	0.25	0.6	G6	-0.725779	0.257981	-6.074530	14.465792	-11.617932	4.586692	-0.890490
777	3.5	0.125	2.5	0.25	0.8	G0	0.307204	0.872562	6.321009	-4.379749	7.588667	-13.236204	5.936393
778	3.5	0.125	2.5	0.25	0.8	G1	0.033723	-0.860076	11.482194	-27.595887	42.604798	-35.731934	11.531278
779	3.5	0.125	2.5	0.25	0.8	G5	-0.515062	1.009484	-3.275712	20.084518	-18.595024	-0.328811	3.582715
780	3.5	0.125	2.5	0.25	0.8	G6	-0.936841	0.098565	-7.667915	10.713270	4.560637	-9.685005	2.916137
781	3.5	0.25	2.5	0.5	0.2	G0	0.899031	-0.697102	4.961208	-10.916128	13.091583	-8.521083	2.303200
782	3.5	0.25	2.5	0.5	0.2	G1	0.134286	0.380995	1.076627	-0.769726	-0.402630	0.304386	-0.021679
783	3.5	0.25	2.5	0.5	0.2	G5	0.850471	-0.537452	3.016722	-4.676394	3.576189	-1.422912	0.202655
784	3.5	0.25	2.5	0.5	0.2	G6	-0.184102	0.192797	-0.806902	1.931565	-1.649948	0.547475	-0.028412
785	3.5	0.25	2.5	0.5	0.4	G0	0.994094	-0.601777	5.144509	-12.164603	15.683333	-11.022270	3.214187
786	3.5	0.25	2.5	0.5	0.4	G1	0.161844	0.403289	1.211076	-1.039873	-0.435212	0.593030	-0.154843
787	3.5	0.25	2.5	0.5	0.4	G5	0.842569	-0.539916	3.410377	-3.414484	-4.590003	9.930612	-4.627675
788	3.5	0.25	2.5	0.5	0.4	G6	-0.359862	0.360096	-1.372917	3.549918	-3.244142	1.118792	-0.048366
789	3.5	0.25	2.5	0.5	0.6	G0	1.144867	-0.387060	4.766777	-9.403235	8.413263	-3.752685	0.697106
790	3.5	0.25	2.5	0.5	0.6	G1	0.205938	0.465678	1.204730	-0.630049	-1.734590	1.813714	-0.518768
791	3.5	0.25	2.5	0.5	0.6	G5	0.826107	-0.191919	3.526355	-9.707863	14.630972	-11.817173	3.816637
792	3.5	0.25	2.5	0.5	0.6	G6	-0.523912	0.516213	-1.845082	5.151293	-4.963991	1.689914	-0.020071
793	3.5	0.25	2.5	0.5	0.8	G0	1.343716	0.050212	5.305349	-10.616317	9.319625	-5.227032	1.692441
794	3.5	0.25	2.5	0.5	0.8	G1	0.261626	0.617556	1.082777	0.405235	-4.088326	3.474133	-0.832308

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
795	3.5	0.25	2.5	0.5	0.8	G5	0.793608	0.616477	-1.658844	12.042666	-25.485199	20.959295	-6.052388
796	3.5	0.25	2.5	0.5	0.8	G6	-0.681961	0.630248	-2.187510	6.744433	-6.611061	1.914347	0.195155
797	3.5	0.5	2.5	1	0.2	G0	1.219167	-0.834186	2.793795	-6.103070	7.238777	-4.452091	1.151366
798	3.5	0.5	2.5	1	0.2	G1	0.186514	0.624839	0.744777	-0.872216	-0.831339	1.315235	-0.457742
799	3.5	0.5	2.5	1	0.2	G5	1.172784	-0.822997	2.097229	-3.712884	3.063501	-0.838495	-0.071605
800	3.5	0.5	2.5	1	0.2	G6	-0.108320	0.151805	-0.434674	1.225038	-1.541382	0.923788	-0.214331
801	3.5	0.5	2.5	1	0.4	G0	1.271327	-0.755291	2.702747	-6.012492	6.438983	-3.504852	0.869469
802	3.5	0.5	2.5	1	0.4	G1	0.198219	0.655969	0.652358	-0.360901	-2.034420	2.233664	-0.648422
803	3.5	0.5	2.5	1	0.4	G5	1.183583	-0.776499	1.586568	-3.712243	5.314290	-4.183114	1.386732
804	3.5	0.5	2.5	1	0.4	G6	-0.212326	0.306959	-0.768599	2.258853	-2.943335	1.741557	-0.380471
805	3.5	0.5	2.5	1	0.6	G0	1.357558	-0.613278	1.904938	-3.366416	1.535739	0.255287	-0.072777
806	3.5	0.5	2.5	1	0.6	G1	0.218785	0.684682	0.500470	0.404414	-3.576632	3.211988	-0.770651
807	3.5	0.5	2.5	1	0.6	G5	1.201684	-0.870960	2.617870	-8.252692	12.017151	-8.193296	2.173949
808	3.5	0.5	2.5	1	0.6	G6	-0.311746	0.458354	-0.925071	2.855357	-3.865436	2.245866	-0.454139
809	3.5	0.5	2.5	1	0.8	G0	1.482378	-0.559720	2.279296	-6.301756	8.153310	-7.058144	2.960963
810	3.5	0.5	2.5	1	0.8	G1	0.246605	0.682650	0.705529	-0.518781	-1.347879	0.259993	0.602443
811	3.5	0.5	2.5	1	0.8	G5	1.224340	-0.807651	1.435728	-0.869255	-6.448674	10.352286	-4.313798
812	3.5	0.5	2.5	1	0.8	G6	-0.404988	0.615050	-1.013029	3.475179	-5.233278	3.291023	-0.726416
813	3.5	1	2.5	2	0.2	G0	0.818791	-0.523110	0.871045	-1.787122	1.892158	-1.503663	0.688853
814	3.5	1	2.5	2	0.2	G1	0.102839	0.546140	0.378159	-0.519539	-0.966804	0.830855	-0.001362
815	3.5	1	2.5	2	0.2	G5	0.790362	-0.543421	0.454176	-0.528874	0.046036	0.028998	0.139182
816	3.5	1	2.5	2	0.2	G6	-0.033354	0.062623	-0.211489	0.628124	-0.884534	0.620775	-0.177991
817	3.5	1	2.5	2	0.4	G0	0.826879	-0.544522	1.121725	-3.016588	4.391971	-3.986572	1.626705
818	3.5	1	2.5	2	0.4	G1	0.102644	0.522883	0.587041	-1.342809	0.752881	-1.024406	0.744444
819	3.5	1	2.5	2	0.4	G5	0.784884	-0.629984	0.539157	-1.153944	1.555009	-1.432874	0.648070
820	3.5	1	2.5	2	0.4	G6	-0.064940	0.123110	-0.351769	1.068626	-1.577669	1.130393	-0.322541
821	3.5	1	2.5	2	0.6	G0	0.839882	-0.572545	1.409921	-4.611690	7.779709	-7.355043	2.877251
822	3.5	1	2.5	2	0.6	G1	0.103909	0.485474	0.903847	-2.682689	3.548002	-3.899965	1.844356
823	3.5	1	2.5	2	0.6	G5	0.782397	-0.690467	0.417175	-1.245746	2.336109	-2.363317	0.995519
824	3.5	1	2.5	2	0.6	G6	-0.095420	0.188874	-0.451092	1.401343	-2.215040	1.664782	-0.487400

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
825	3.5	1	2.5	2	0.8	G0	0.859297	-0.624851	1.831157	-6.745372	11.962337	-11.190216	4.204363
826	3.5	1	2.5	2	0.8	G1	0.106237	0.426193	1.405590	-4.754746	7.584638	-7.723315	3.204929
827	3.5	1	2.5	2	0.8	G5	0.780634	-0.757415	0.400018	-2.001873	4.403633	-4.261393	1.587867
828	3.5	1	2.5	2	0.8	G6	-0.124997	0.261395	-0.523253	1.681075	-2.904270	2.319604	-0.702764
829	4	0.015625	3	0.03125	0.2	G0	too long						
830	4	0.015625	3	0.03125	0.2	G1	too long						
831	4	0.015625	3	0.03125	0.2	G5	too long						
832	4	0.015625	3	0.03125	0.2	G6	too long						
833	4	0.015625	3	0.03125	0.4	G0	too long						
834	4	0.015625	3	0.03125	0.4	G1	too long						
835	4	0.015625	3	0.03125	0.4	G5	too long						
836	4	0.015625	3	0.03125	0.4	G6	too long						
837	4	0.015625	3	0.03125	0.6	G0	too long						
838	4	0.015625	3	0.03125	0.6	G1	too long						
839	4	0.015625	3	0.03125	0.6	G5	too long						
840	4	0.015625	3	0.03125	0.6	G6	too long						
841	4	0.015625	3	0.03125	0.8	G0	too long						
842	4	0.015625	3	0.03125	0.8	G1	too long						
843	4	0.015625	3	0.03125	0.8	G5	too long						
844	4	0.015625	3	0.03125	0.8	G6	too long						
845	4	0.03125	3	0.0625	0.2	G0	0.232797	2.408139	-3.195721	4.323159	-3.264773	0.771071	0.035246
846	4	0.03125	3	0.0625	0.2	G1	0.003581	0.175540	2.472642	-3.269614	2.890415	-2.230988	0.713746
847	4	0.03125	3	0.0625	0.2	G5	-0.161758	-2.344199	6.960485	-13.222033	31.655401	-31.632271	9.910460
848	4	0.03125	3	0.0625	0.2	G6	-0.160464	-2.141958	3.817228	-12.874300	15.523235	-0.189679	-3.977852
849	4	0.03125	3	0.0625	0.4	G0	too long						
850	4	0.03125	3	0.0625	0.4	G1	too long						
851	4	0.03125	3	0.0625	0.4	G5	too long						
852	4	0.03125	3	0.0625	0.4	G6	too long						
853	4	0.03125	3	0.0625	0.6	G0	too long						
854	4	0.03125	3	0.0625	0.6	G1	too long						

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
855	4	0.03125	3	0.0625	0.6	G5	too long						
856	4	0.03125	3	0.0625	0.6	G6	too long						
857	4	0.03125	3	0.0625	0.8	G0	too long						
858	4	0.03125	3	0.0625	0.8	G1	too long						
859	4	0.03125	3	0.0625	0.8	G5	too long						
860	4	0.03125	3	0.0625	0.8	G6	too long						
861	4	0.0625	3	0.125	0.2	G0	0.407240	0.881898	5.132923	-18.428025	28.723110	-21.913626	6.486562
862	4	0.0625	3	0.125	0.2	G1	0.032015	0.208373	2.472138	-3.581163	3.189646	-2.306871	0.729262
863	4	0.0625	3	0.125	0.2	G5	0.168313	0.572771	0.711969	0.337033	1.375201	-3.583373	1.567646
864	4	0.0625	3	0.125	0.2	G6	-0.347676	-1.034024	-1.909452	9.353003	-11.180316	7.225214	-2.105167
865	4	0.0625	3	0.125	0.4	G0	0.336414	0.500329	6.522439	-19.908727	33.826848	-28.416141	8.847111
866	4	0.0625	3	0.125	0.4	G1	-0.002117	0.158436	2.355133	-2.387438	2.657041	-2.950807	1.069227
867	4	0.0625	3	0.125	0.4	G5	-0.330079	-0.820162	0.193235	4.028705	10.139735	-19.057772	7.163984
868	4	0.0625	3	0.125	0.4	G6	-0.371296	-0.757652	-4.121877	6.304007	-7.191635	13.428007	-7.292659
869	4	0.0625	3	0.125	0.6	G0	too long						
870	4	0.0625	3	0.125	0.6	G1	too long						
871	4	0.0625	3	0.125	0.6	G5	too long						
872	4	0.0625	3	0.125	0.6	G6	too long						
873	4	0.0625	3	0.125	0.8	G0	too long						
874	4	0.0625	3	0.125	0.8	G1	too long						
875	4	0.0625	3	0.125	0.8	G5	too long						
876	4	0.0625	3	0.125	0.8	G6	too long						
877	4	0.125	3	0.25	0.2	G0	0.647084	-0.528532	9.262426	-26.251039	37.346864	-27.055721	7.797888
878	4	0.125	3	0.25	0.2	G1	0.079159	0.190235	2.317997	-3.403834	2.871308	-1.918756	0.583446
879	4	0.125	3	0.25	0.2	G5	0.542212	-0.219623	4.784004	-7.727555	2.464825	3.831226	-2.584167
880	4	0.125	3	0.25	0.2	G6	-0.300599	0.171738	-2.911559	8.319340	-8.758313	4.257839	-0.775900
881	4	0.125	3	0.25	0.4	G0	0.711934	-0.500330	10.129381	-26.905306	36.979476	-26.342991	7.475923
882	4	0.125	3	0.25	0.4	G1	0.096269	0.227009	2.499063	-3.471185	2.828967	-1.975194	0.625987
883	4	0.125	3	0.25	0.4	G5	0.331240	0.301230	1.559593	-0.117142	-0.530005	-0.973855	0.653302
884	4	0.125	3	0.25	0.4	G6	-0.553321	0.333968	-5.217353	14.144399	-14.297375	6.954299	-1.361273

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
885	4	0.125	3	0.25	0.6	G0	0.640343	-0.020839	9.338531	-21.402223	30.144240	-23.933646	7.464794
886	4	0.125	3	0.25	0.6	G1	0.069994	0.365553	2.295054	-1.559691	0.148839	-0.699161	0.438978
887	4	0.125	3	0.25	0.6	G5	-0.027353	0.238961	0.714585	8.204041	-13.008048	6.535464	-1.168343
888	4	0.125	3	0.25	0.6	G6	-0.744808	0.240870	-6.311386	14.791185	-11.539640	4.444598	-0.878999
889	4	0.125	3	0.25	0.8	G0	0.167922	1.197860	4.428925	2.638901	-1.274556	-8.695864	5.128669
890	4	0.125	3	0.25	0.8	G1	0.121329	-2.626898	20.610111	-50.113245	72.939443	-56.737009	17.329902
891	4	0.125	3	0.25	0.8	G5	-0.634688	0.787310	-1.813778	15.830370	-9.981714	-8.552686	6.373093
892	4	0.125	3	0.25	0.8	G6	-0.985620	0.041683	-7.721091	7.471664	13.275793	-17.102539	5.018599
893	4	0.25	3	0.5	0.2	G0	0.899888	-0.688287	4.957977	-10.944747	13.138705	-8.550607	2.310352
894	4	0.25	3	0.5	0.2	G1	0.134596	0.381806	1.091509	-0.830201	-0.307469	0.234016	-0.001334
895	4	0.25	3	0.5	0.2	G5	0.850191	-0.553797	3.189651	-5.494405	5.184900	-2.812129	0.642088
896	4	0.25	3	0.5	0.2	G6	-0.192992	0.202184	-0.853746	2.077002	-1.834135	0.659078	-0.054908
897	4	0.25	3	0.5	0.4	G0	0.998690	-0.592855	5.287802	-12.822303	16.848923	-11.966725	3.504084
898	4	0.25	3	0.5	0.4	G1	0.163046	0.413322	1.166128	-0.854790	-0.804290	0.916474	-0.257871
899	4	0.25	3	0.5	0.4	G5	0.835402	-0.444105	2.327560	0.956101	-12.307252	16.125980	-6.484058
900	4	0.25	3	0.5	0.4	G6	-0.375866	0.378947	-1.482100	3.981929	-3.957598	1.674551	-0.216428
901	4	0.25	3	0.5	0.6	G0	1.155278	-0.299271	4.456842	-8.519395	7.126406	-2.931453	0.519386
902	4	0.25	3	0.5	0.6	G1	0.208975	0.477062	1.235816	-0.724860	-1.620698	1.711485	-0.473769
903	4	0.25	3	0.5	0.6	G5	0.812100	-0.334569	5.077700	-14.300287	20.594437	-15.309299	4.543179
904	4	0.25	3	0.5	0.6	G6	-0.544486	0.521086	-1.807819	5.102059	-4.831253	1.508893	0.055902
905	4	0.25	3	0.5	0.8	G0	1.358743	0.258158	4.347345	-6.687381	2.079421	0.571776	0.002718
906	4	0.25	3	0.5	0.8	G1	0.265039	0.664440	0.975181	0.842547	-4.831924	3.901920	-0.882703
907	4	0.25	3	0.5	0.8	G5	0.757720	0.603741	0.477189	2.123710	-6.185174	3.756816	-0.307392
908	4	0.25	3	0.5	0.8	G6	-0.707859	0.641524	-2.174056	6.725723	-6.289503	1.377131	0.430632
909	4	0.5	3	1	0.2	G0	1.219715	-0.826112	2.771565	-6.056398	7.142432	-4.361354	1.122749
910	4	0.5	3	1	0.2	G1	0.186482	0.627255	0.736214	-0.830453	-0.928983	1.401471	-0.482895
911	4	0.5	3	1	0.2	G5	1.170143	-0.778305	1.657095	-1.980794	-0.165226	1.973126	-0.994580
912	4	0.5	3	1	0.2	G6	-0.113517	0.158179	-0.449035	1.274862	-1.614380	0.972432	-0.226624
913	4	0.5	3	1	0.4	G0	1.273132	-0.736722	2.657894	-5.911180	6.229734	-3.332182	0.826590
914	4	0.5	3	1	0.4	G1	0.198474	0.658339	0.661161	-0.381917	-2.025233	2.212453	-0.629425

Run ID	Y = OD/ID	a/l = a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
915	4	0.5	3	1	0.4	G5	1.181243	-0.784638	1.691609	-4.277567	6.388563	-5.064320	1.652247
916	4	0.5	3	1	0.4	G6	-0.222319	0.322060	-0.800708	2.387451	-3.163373	1.905923	-0.426423
917	4	0.5	3	1	0.6	G0	1.362440	-0.565511	1.708499	-2.933598	1.059299	0.377648	-0.014046
918	4	0.5	3	1	0.6	G1	0.219423	0.695278	0.460264	0.523260	-3.723559	3.212568	-0.720344
919	4	0.5	3	1	0.6	G5	1.195219	-0.896080	2.891668	-8.870137	12.149021	-7.610339	1.814716
920	4	0.5	3	1	0.6	G6	-0.325787	0.482102	-0.961986	3.037835	-4.226598	2.538868	-0.541320
921	4	0.5	3	1	0.8	G0	1.493776	-0.552029	2.571585	-7.756467	10.993048	-9.768668	3.956321
922	4	0.5	3	1	0.8	G1	0.248437	0.683650	0.770085	-0.859648	-0.519801	-0.741575	1.033950
923	4	0.5	3	1	0.8	G5	1.213776	-0.649866	0.034696	4.279867	-15.331769	17.391764	-6.392768
924	4	0.5	3	1	0.8	G6	-0.422230	0.647202	-1.044534	3.699807	-5.744789	3.722471	-0.854438
925	4	1	3	2	0.2	G0	0.818616	-0.521582	0.869584	-1.805350	1.950267	-1.579292	0.722536
926	4	1	3	2	0.2	G1	0.102683	0.545509	0.385622	-0.551150	-0.895017	0.746502	0.034559
927	4	1	3	2	0.2	G5	0.789471	-0.544741	0.435198	-0.475383	-0.022934	0.069549	0.130848
928	4	1	3	2	0.2	G6	-0.034930	0.065059	-0.217685	0.650285	-0.920559	0.647741	-0.185778
929	4	1	3	2	0.4	G0	0.826702	-0.543653	1.139311	-3.141996	4.679831	-4.289729	1.743975
930	4	1	3	2	0.4	G1	0.102395	0.520080	0.615877	-1.467343	1.018310	-1.303877	0.853387
931	4	1	3	2	0.4	G5	0.783584	-0.650183	0.695348	-1.838576	2.884726	-2.613762	1.040876
932	4	1	3	2	0.4	G6	-0.067988	0.128554	-0.357448	1.086668	-1.610184	1.154633	-0.329039
933	4	1	3	2	0.6	G0	0.839999	-0.574809	1.471198	-4.951538	8.485961	-8.032164	3.119156
934	4	1	3	2	0.6	G1	0.103650	0.478524	0.972922	-2.983256	4.161300	-4.502719	2.065060
935	4	1	3	2	0.6	G5	0.779726	-0.693194	0.393994	-1.334706	2.694973	-2.764783	1.143293
936	4	1	3	2	0.6	G6	-0.099864	0.199472	-0.468196	1.467681	-2.355636	1.790445	-0.527892
937	4	1	3	2	0.8	G0	0.860011	-0.629880	1.926018	-7.246794	12.902993	-11.991946	4.459634
938	4	1	3	2	0.8	G1	0.105999	0.414572	1.507646	-5.167247	8.338036	-8.392425	3.429546
939	4	1	3	2	0.8	G5	0.776885	-0.773059	0.466970	-2.388405	5.133531	-4.809737	1.729769
940	4	1	3	2	0.8	G6	-0.130757	0.275729	-0.526799	1.700814	-2.991658	2.413368	-0.733926

APPENDIX D: CIRCUMFERENTIAL EXTERNAL 360° CRACK RESULTS

The circumferential external 360° partial-depth crack has a constant G value along the crack front around the cylinder circumference, so only the A0 polynomial coefficient value is reported for the non-dimensional geometry factor G results. There are 5 load cases for the 360° crack: G0 is the uniform crack face pressure, G1 is the linear crack face pressure, G2 is the quadratic crack face pressure, G3 is the cubic crack face pressure, and G4 is the quartic (4^{th} order) crack face pressure.

Table 8: Non-Dimensional Geometry Polynomial Coefficient Values for Circumferential External 360° Cracks

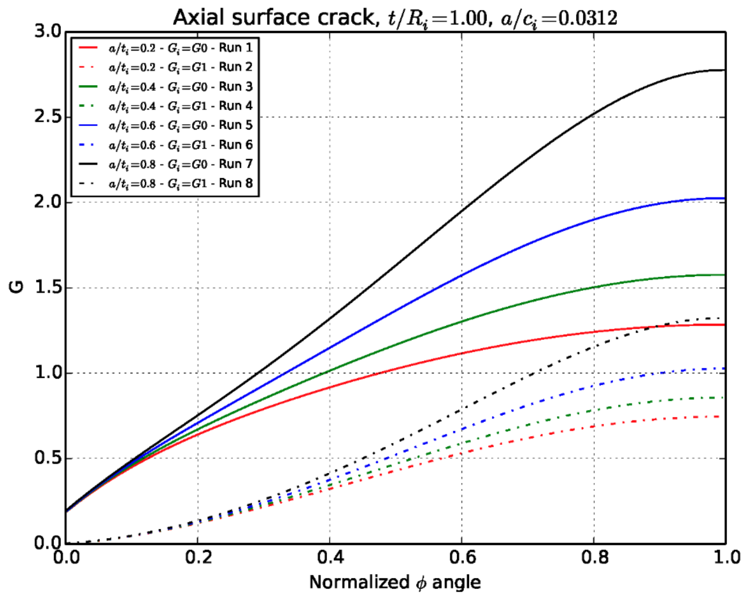
Run ID	Y = OD/ID	t/Ri	a/t	Gi	A0
1100	2	1	0.2	G0	1.232973
1101	2	1	0.2	G1	0.725583
1102	2	1	0.2	G2	0.549530
1103	2	1	0.2	G3	0.457007
1104	2	1	0.2	G4	0.398605
1105	2	1	0.4	G0	1.429609
1106	2	1	0.4	G1	0.800092
1107	2	1	0.4	G2	0.590755
1108	2	1	0.4	G3	0.483843
1109	2	1	0.4	G4	0.417727
1110	2	1	0.6	G0	1.779493
1111	2	1	0.6	G1	0.934332
1112	2	1	0.6	G2	0.665826
1113	2	1	0.6	G3	0.533220
1114	2	1	0.6	G4	0.453295
1115	2	1	0.8	G0	2.593457
1116	2	1	0.8	G1	1.259538
1117	2	1	0.8	G2	0.852399
1118	2	1	0.8	G3	0.658163
1119	2	1	0.8	G4	0.544530
1120	2.5	1.5	0.2	G0	1.231001
1121	2.5	1.5	0.2	G1	0.724549
1122	2.5	1.5	0.2	G2	0.548801
1123	2.5	1.5	0.2	G3	0.456410
1124	2.5	1.5	0.2	G4	0.398071
1125	2.5	1.5	0.4	G0	1.428822
1126	2.5	1.5	0.4	G1	0.799833
1127	2.5	1.5	0.4	G2	0.590603
1128	2.5	1.5	0.4	G3	0.483722
1129	2.5	1.5	0.4	G4	0.417613
1130	2.5	1.5	0.6	G0	1.811186

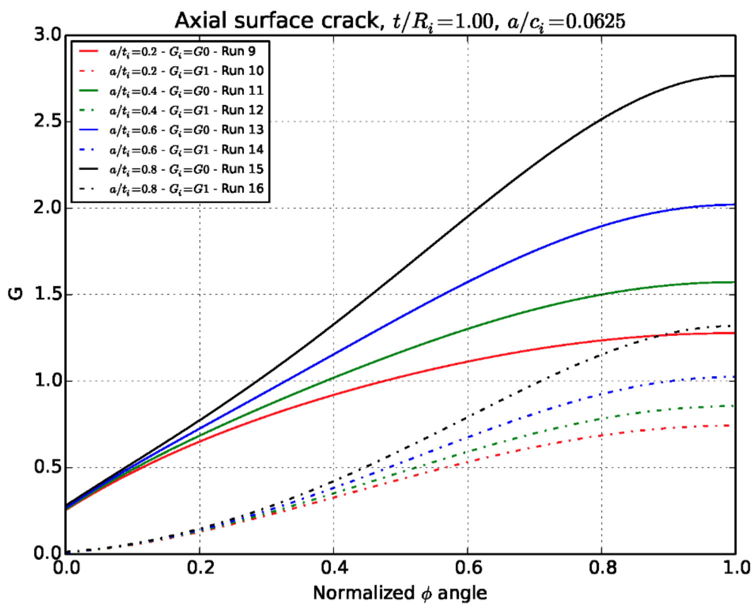
Run ID	Y = OD/ID	t/Ri	a/t	Gi	A0
1131	2.5	1.5	0.6	G1	0.946320
1132	2.5	1.5	0.6	G2	0.672404
1133	2.5	1.5	0.6	G3	0.537469
1134	2.5	1.5	0.6	G4	0.456304
1135	2.5	1.5	0.8	G0	2.757031
1136	2.5	1.5	0.8	G1	1.316829
1137	2.5	1.5	0.8	G2	0.882279
1138	2.5	1.5	0.8	G3	0.676781
1139	2.5	1.5	0.8	G4	0.557379
1140	3	2	0.2	G0	1.231398
1141	3	2	0.2	G1	0.724571
1142	3	2	0.2	G2	0.548748
1143	3	2	0.2	G3	0.456325
1144	3	2	0.2	G4	0.397966
1145	3	2	0.4	G0	1.435843
1146	3	2	0.4	G1	0.802596
1147	3	2	0.4	G2	0.592156
1148	3	2	0.4	G3	0.484737
1149	3	2	0.4	G4	0.418336
1150	3	2	0.6	G0	1.851603
1151	3	2	0.6	G1	0.961476
1152	3	2	0.6	G2	0.680693
1153	3	2	0.6	G3	0.542820
1154	3	2	0.6	G4	0.460100
1155	3	2	0.8	G0	2.920115
1156	3	2	0.8	G1	1.374001
1157	3	2	0.8	G2	0.912127
1158	3	2	0.8	G3	0.695398
1159	3	2	0.8	G4	0.570240
1160	3.5	2.5	0.2	G0	1.232576
1161	3.5	2.5	0.2	G1	0.724952
1162	3.5	2.5	0.2	G2	0.548925
1163	3.5	2.5	0.2	G3	0.456415
1164	3.5	2.5	0.2	G4	0.398008
1165	3.5	2.5	0.4	G0	1.444794
1166	3.5	2.5	0.4	G1	0.806090
1167	3.5	2.5	0.4	G2	0.594116
1168	3.5	2.5	0.4	G3	0.486024
1169	3.5	2.5	0.4	G4	0.419258
1170	3.5	2.5	0.6	G0	1.891474
1171	3.5	2.5	0.6	G1	0.976367

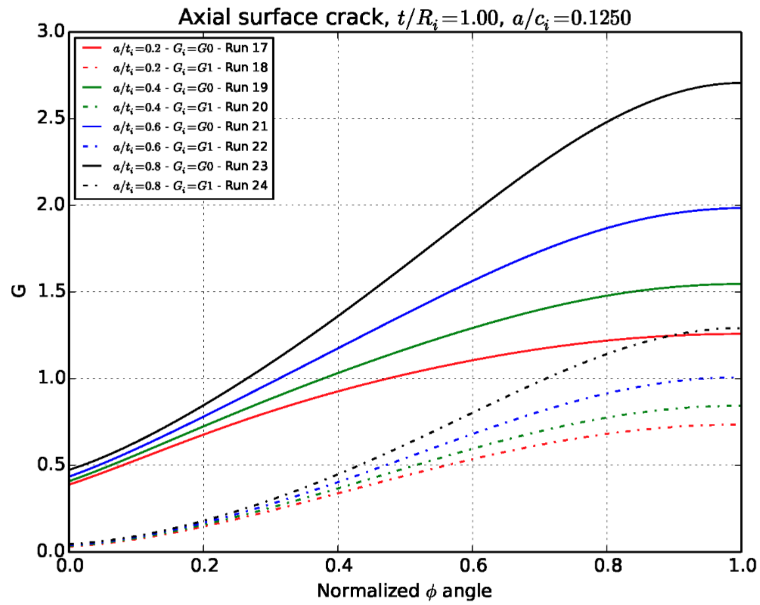
Run ID	Y = OD/ID	t/Ri	a/t	Gi	A0
1172	3.5	2.5	0.6	G2	0.688822
1173	3.5	2.5	0.6	G3	0.548064
1174	3.5	2.5	0.6	G4	0.463819
1175	3.5	2.5	0.8	G0	3.073141
1176	3.5	2.5	0.8	G1	1.427641
1177	3.5	2.5	0.8	G2	0.940133
1178	3.5	2.5	0.8	G3	0.712870
1179	3.5	2.5	0.8	G4	0.582312
1180	4	3	0.2	G0	1.233992
1181	4	3	0.2	G1	0.725453
1182	4	3	0.2	G2	0.549184
1183	4	3	0.2	G3	0.456569
1184	4	3	0.2	G4	0.398105
1185	4	3	0.4	G0	1.453863
1186	4	3	0.4	G1	0.809615
1187	4	3	0.4	G2	0.596092
1188	4	3	0.4	G3	0.487321
1189	4	3	0.4	G4	0.420189
1190	4	3	0.6	G0	1.928454
1191	4	3	0.6	G1	0.990140
1192	4	3	0.6	G2	0.696330
1193	4	3	0.6	G3	0.552903
1194	4	3	0.6	G4	0.467250
1195	4	3	0.8	G0	3.214424
1196	4	3	0.8	G1	1.477147
1197	4	3	0.8	G2	0.965978
1198	4	3	0.8	G3	0.728993
1199	4	3	0.8	G4	0.593452

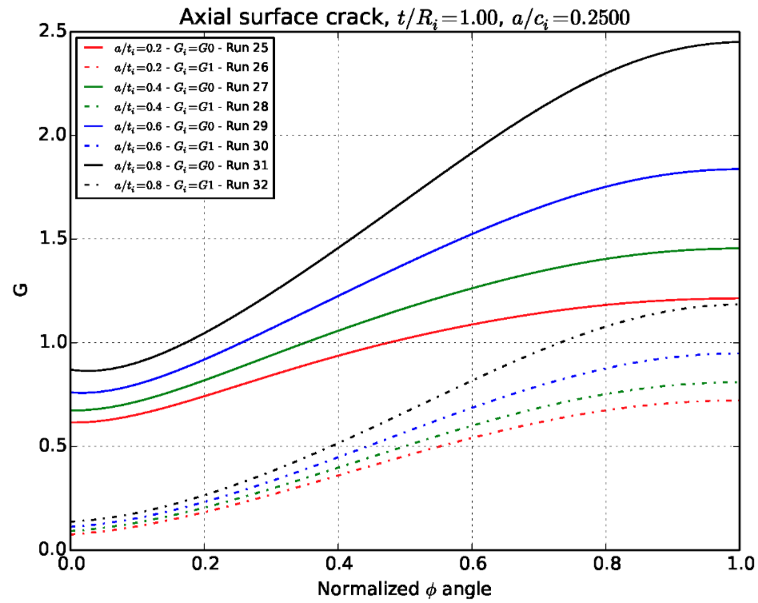
APPENDIX E: AXIAL EXTERNAL SURFACE CRACK G RESULTS

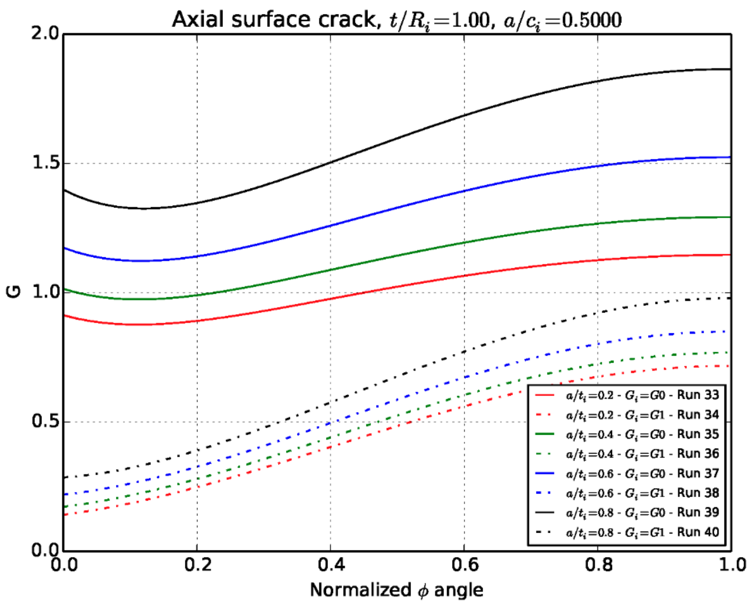
Plots of all the axial external surface crack cases, G versus the normalized crack front angle position $2\phi/\pi$. Eight curves per plot to show the uniform G_0 and linear G_1 load cases for the four a/t ratios. Each page contains the plot for a particular t/Ri and a/c ratio. There are 35 total plots.

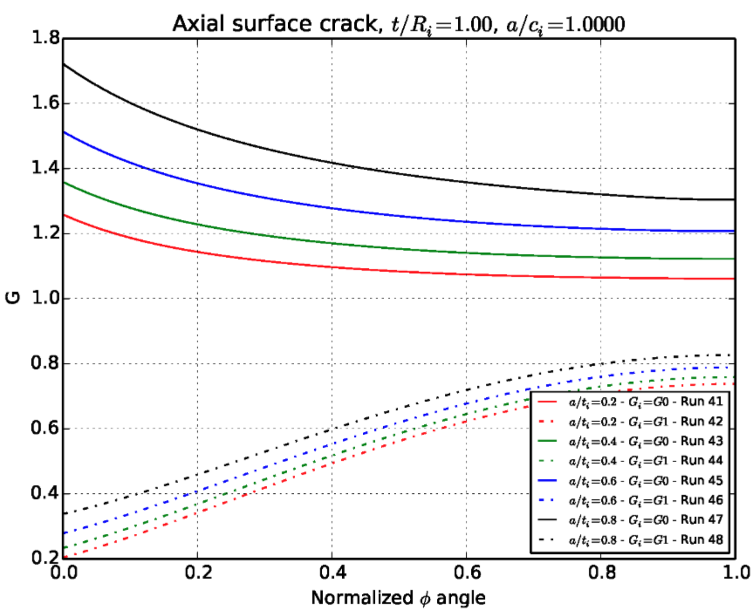


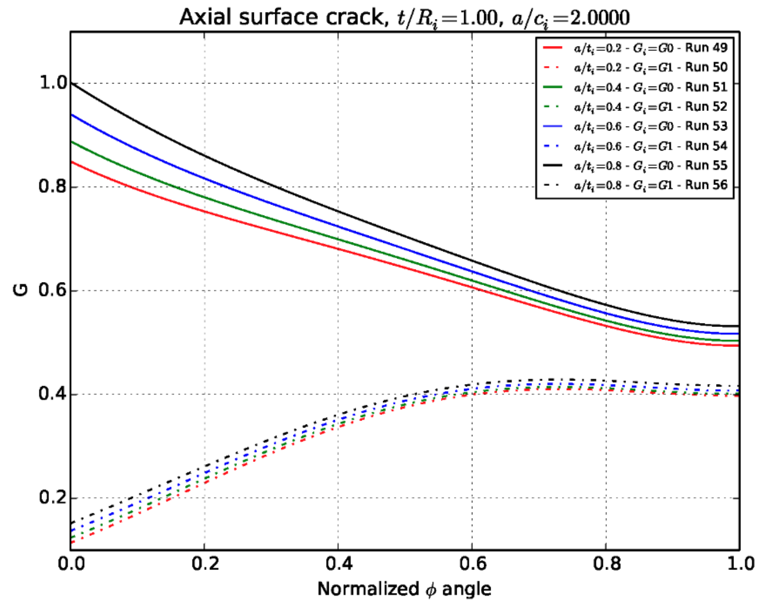


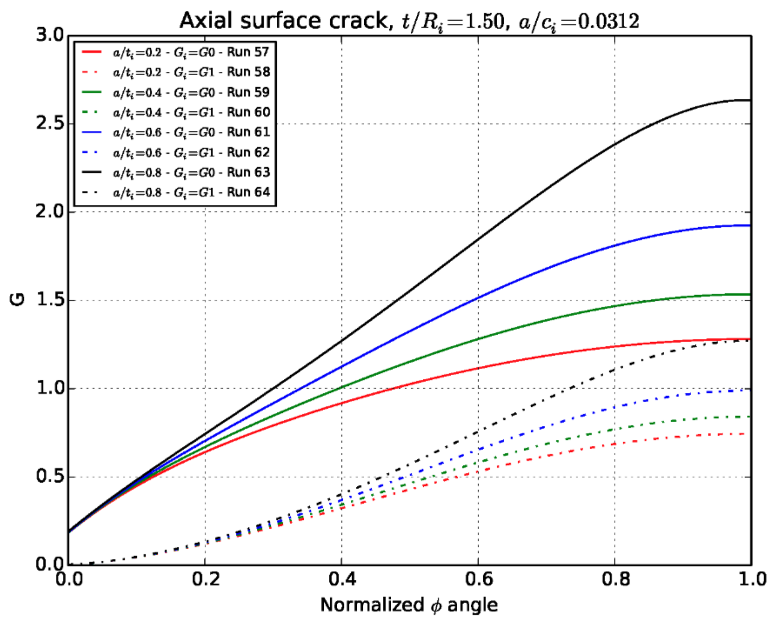

Axial surface crack, $t/R_i=1.00$, $a/c_i=0.1250$
$a/t_i=0.2$ - $G_i=G0$ - Run 17
$a/t_i=0.2$ - $G_i=G1$ - Run 18
$a/t_i=0.4$ - $G_i=G0$ - Run 19
$a/t_i=0.4$ - $G_i=G1$ - Run 20
$a/t_i=0.6$ - $G_i=G0$ - Run 21
$a/t_i=0.6$ - $G_i=G1$ - Run 22
$a/t_i=0.8$ - $G_i=G0$ - Run 23
$a/t_i=0.8$ - $G_i=G1$ - Run 24
G
Normalized ϕ angle

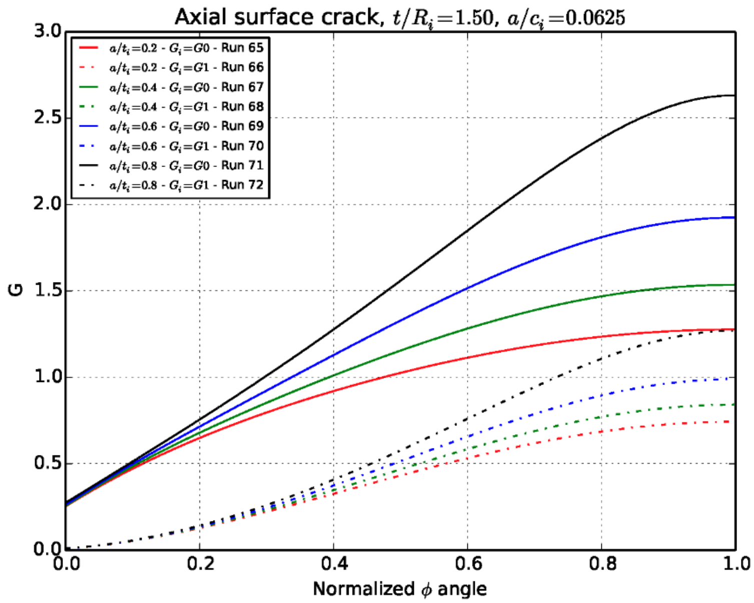

Axial surface crack, $t/R_i=1.00$, $a/c_i=0.2500$
$a/t_i=0.2$ - $G_i=G0$ - Run 25
$a/t_i=0.2$ - $G_i=G1$ - Run 26
$a/t_i=0.4$ - $G_i=G0$ - Run 27
$a/t_i=0.4$ - $G_i=G1$ - Run 28
$a/t_i=0.6$ - $G_i=G0$ - Run 29
$a/t_i=0.6$ - $G_i=G1$ - Run 30
$a/t_i=0.8$ - $G_i=G0$ - Run 31
$a/t_i=0.8$ - $G_i=G1$ - Run 32
G
Normalized ϕ angle

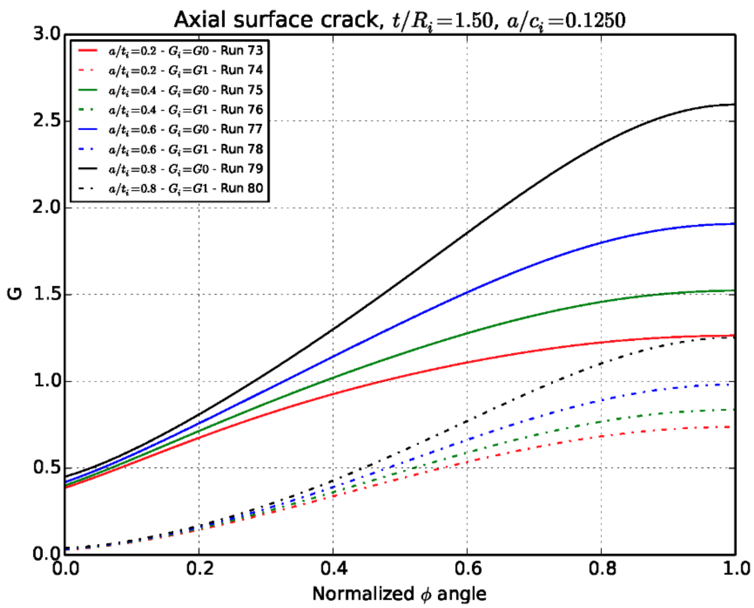

Axial surface crack, $t/R_i = 1.00$, $a/c_i = 0.5000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 33
$a/t_i = 0.2$ - $G_i = G1$ - Run 34
$a/t_i = 0.4$ - $G_i = G0$ - Run 35
$a/t_i = 0.4$ - $G_i = G1$ - Run 36
$a/t_i = 0.6$ - $G_i = G0$ - Run 37
$a/t_i = 0.6$ - $G_i = G1$ - Run 38
$a/t_i = 0.8$ - $G_i = G0$ - Run 39
$a/t_i = 0.8$ - $G_i = G1$ - Run 40

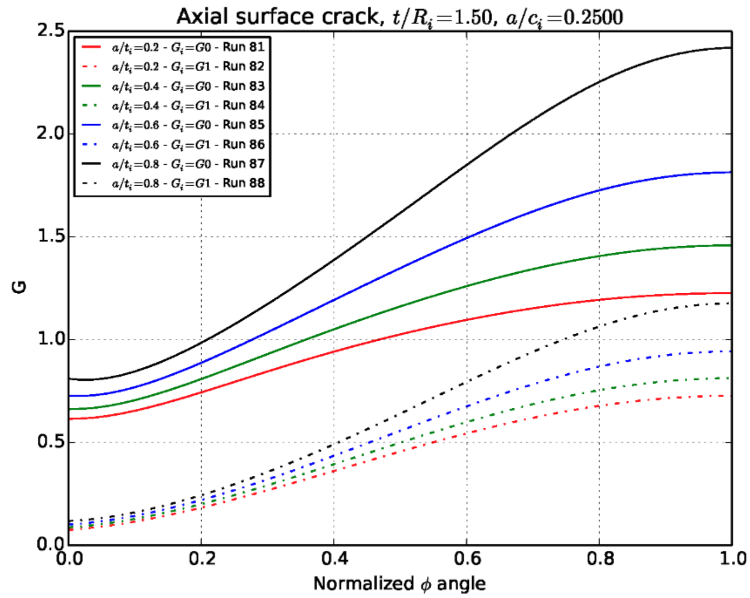

Axial surface crack, $t/R_i = 1.00$, $a/c_i = 1.0000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 41
$a/t_i = 0.2$ - $G_i = G1$ - Run 42
$a/t_i = 0.4$ - $G_i = G0$ - Run 43
$a/t_i = 0.4$ - $G_i = G1$ - Run 44
$a/t_i = 0.6$ - $G_i = G0$ - Run 45
$a/t_i = 0.6$ - $G_i = G1$ - Run 46
$a/t_i = 0.8$ - $G_i = G0$ - Run 47
$a/t_i = 0.8$ - $G_i = G1$ - Run 48

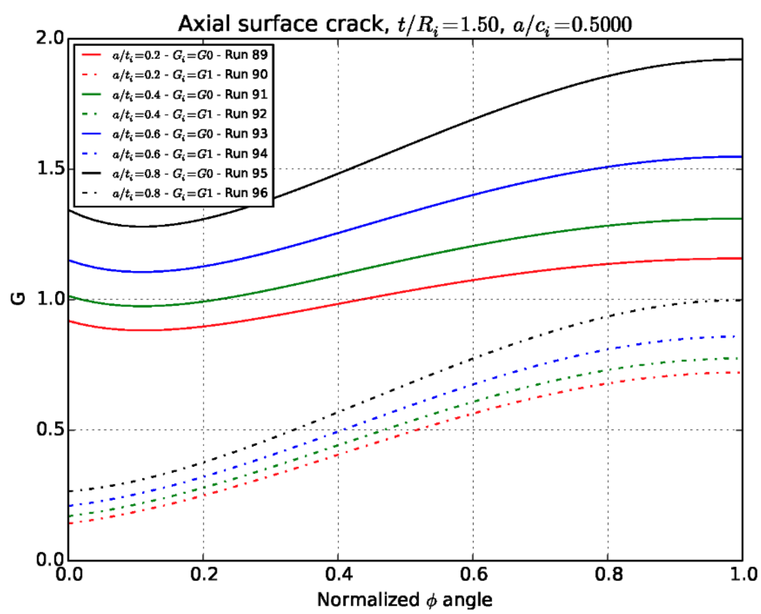

Axial surface crack, $t/R_i=1.00$, $a/c_i=2.0000$
$a/t_i=0.2$ - $G_i=G0$ - Run 49
$a/t_i=0.2$ - $G_i=G1$ - Run 50
$a/t_i=0.4$ - $G_i=G0$ - Run 51
$a/t_i=0.4$ - $G_i=G1$ - Run 52
$a/t_i=0.6$ - $G_i=G0$ - Run 53
$a/t_i=0.6$ - $G_i=G1$ - Run 54
$a/t_i=0.8$ - $G_i=G0$ - Run 55
$a/t_i=0.8$ - $G_i=G1$ - Run 56
G
Normalized ϕ angle

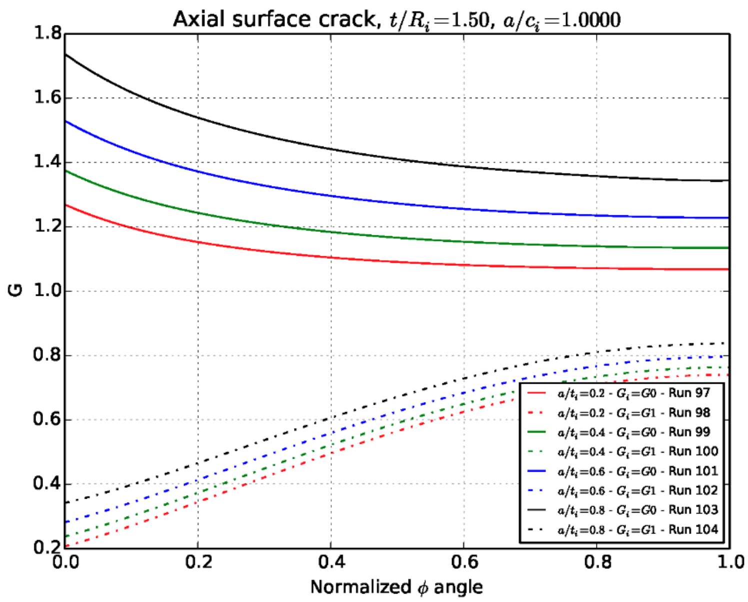

Axial surface crack, $t/R_i=1.50$, $a/c_i=0.0312$
$a/t_i=0.2$ - $G_i=G0$ - Run 57
$a/t_i=0.2$ - $G_i=G1$ - Run 58
$a/t_i=0.4$ - $G_i=G0$ - Run 59
$a/t_i=0.4$ - $G_i=G1$ - Run 60
$a/t_i=0.6$ - $G_i=G0$ - Run 61
$a/t_i=0.6$ - $G_i=G1$ - Run 62
$a/t_i=0.8$ - $G_i=G0$ - Run 63
$a/t_i=0.8$ - $G_i=G1$ - Run 64
G
Normalized ϕ angle

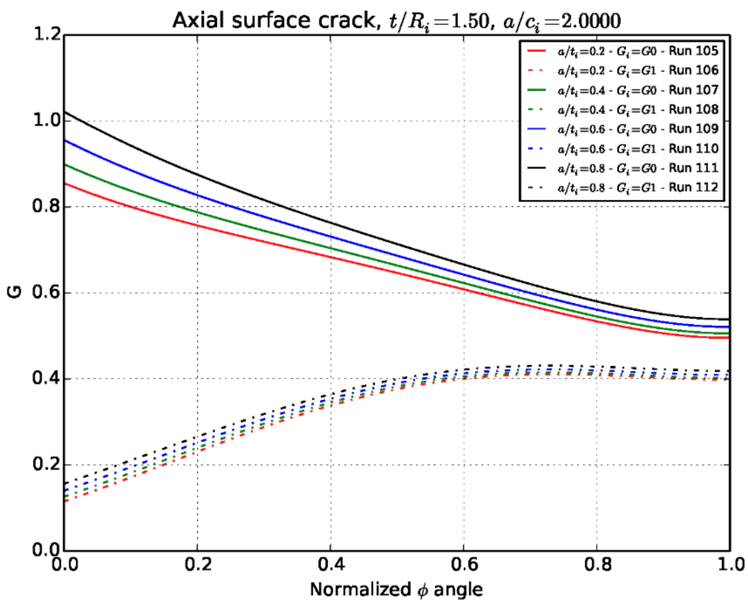

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 65
$a/t_i = 0.2$ - $G_i = G1$ - Run 66
$a/t_i = 0.4$ - $G_i = G0$ - Run 67
$a/t_i = 0.4$ - $G_i = G1$ - Run 68
$a/t_i = 0.6$ - $G_i = G0$ - Run 69
$a/t_i = 0.6$ - $G_i = G1$ - Run 70
$a/t_i = 0.8$ - $G_i = G0$ - Run 71
$a/t_i = 0.8$ - $G_i = G1$ - Run 72
G
Normalized ϕ angle

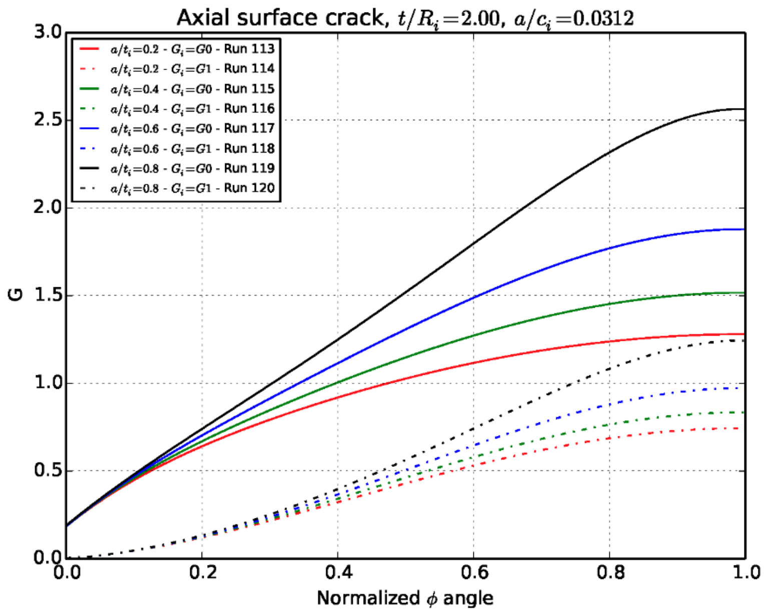

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 73
$a/t_i = 0.2$ - $G_i = G1$ - Run 74
$a/t_i = 0.4$ - $G_i = G0$ - Run 75
$a/t_i = 0.4$ - $G_i = G1$ - Run 76
$a/t_i = 0.6$ - $G_i = G0$ - Run 77
$a/t_i = 0.6$ - $G_i = G1$ - Run 78
$a/t_i = 0.8$ - $G_i = G0$ - Run 79
$a/t_i = 0.8$ - $G_i = G1$ - Run 80
G
Normalized ϕ angle

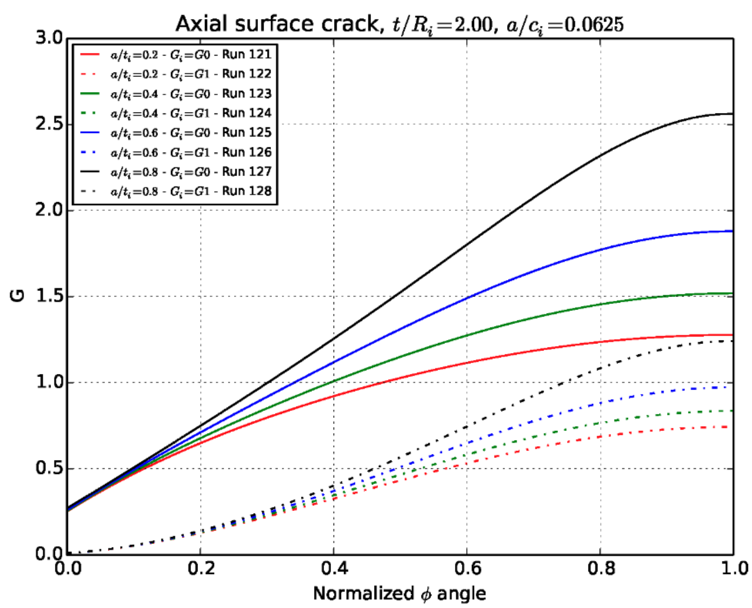

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 81
$a/t_i = 0.2$ - $G_i = G1$ - Run 82
$a/t_i = 0.4$ - $G_i = G0$ - Run 83
$a/t_i = 0.4$ - $G_i = G1$ - Run 84
$a/t_i = 0.6$ - $G_i = G0$ - Run 85
$a/t_i = 0.6$ - $G_i = G1$ - Run 86
$a/t_i = 0.8$ - $G_i = G0$ - Run 87
$a/t_i = 0.8$ - $G_i = G1$ - Run 88
G
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

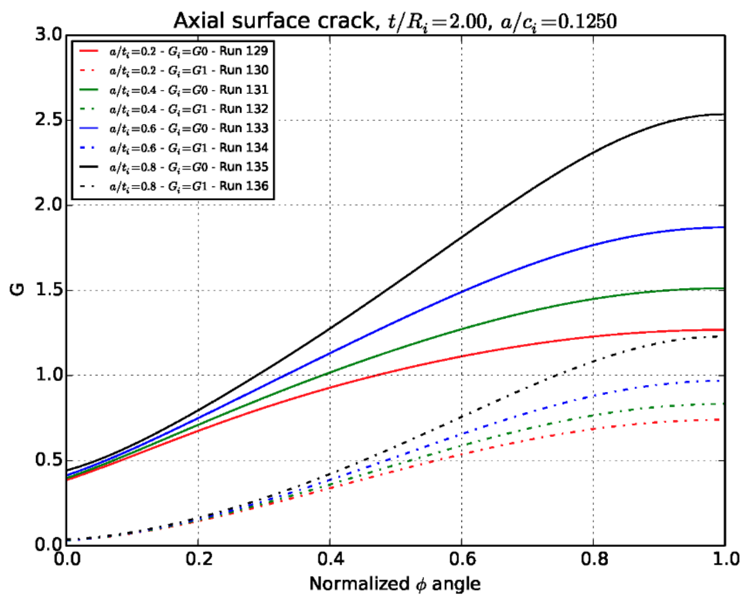

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 0.5000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 89
$a/t_i = 0.2$ - $G_i = G1$ - Run 90
$a/t_i = 0.4$ - $G_i = G0$ - Run 91
$a/t_i = 0.4$ - $G_i = G1$ - Run 92
$a/t_i = 0.6$ - $G_i = G0$ - Run 93
$a/t_i = 0.6$ - $G_i = G1$ - Run 94
$a/t_i = 0.8$ - $G_i = G0$ - Run 95
$a/t_i = 0.8$ - $G_i = G1$ - Run 96
G
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

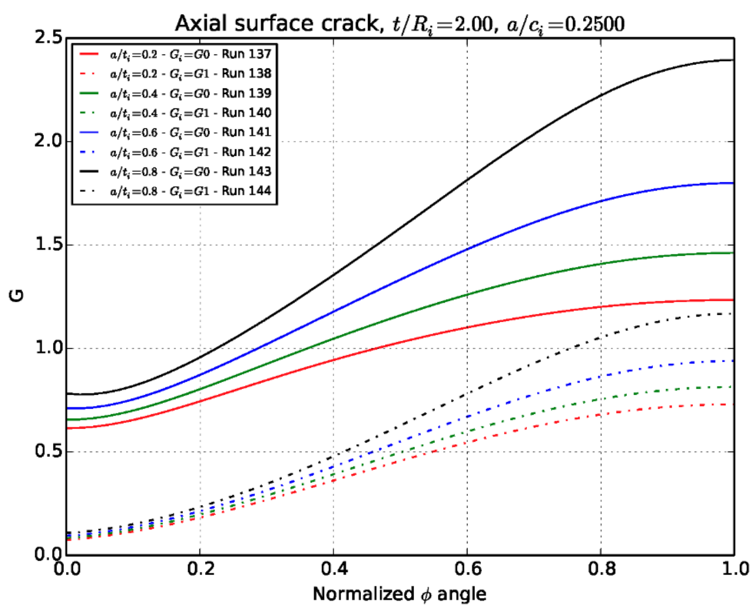

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 97
a/t_i=0.2 - G_i=G1 - Run 98
a/t_i=0.4 - G_i=G0 - Run 99
a/t_i=0.4 - G_i=G1 - Run 100
a/t_i=0.6 - G_i=G0 - Run 101
a/t_i=0.6 - G_i=G1 - Run 102
a/t_i=0.8 - G_i=G0 - Run 103
a/t_i=0.8 - G_i=G1 - Run 104

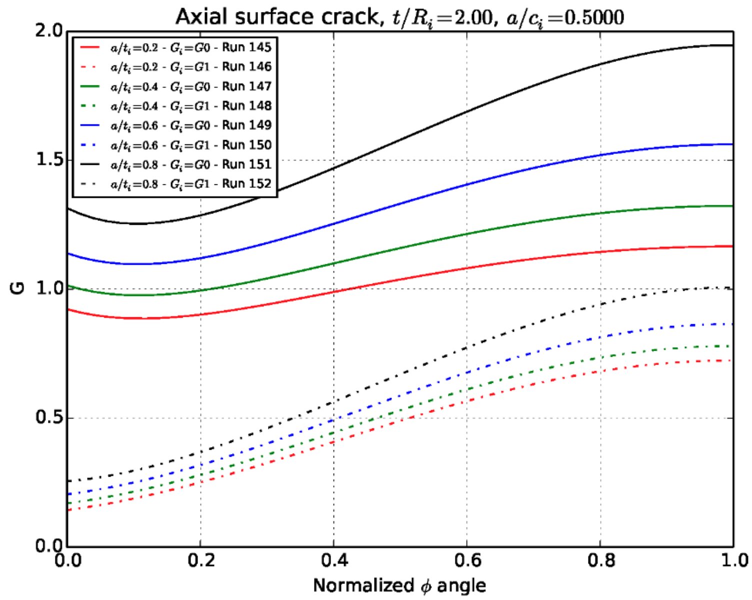

Axial surface crack, $t/R_i = 1.50$, $a/c_i = 2.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 105
a/t_i=0.2 - G_i=G1 - Run 106
a/t_i=0.4 - G_i=G0 - Run 107
a/t_i=0.4 - G_i=G1 - Run 108
a/t_i=0.6 - G_i=G0 - Run 109
a/t_i=0.6 - G_i=G1 - Run 110
a/t_i=0.8 - G_i=G0 - Run 111
a/t_i=0.8 - G_i=G1 - Run 112

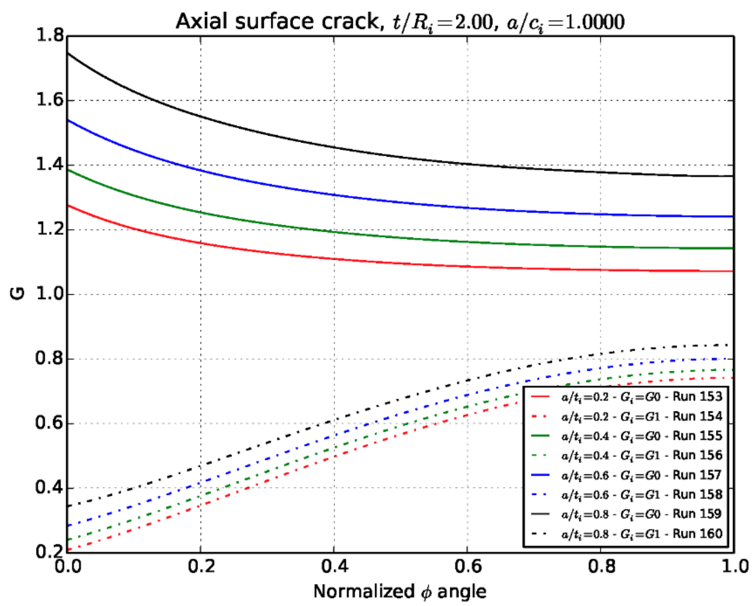

Axial surface crack, $t/R_i = 2.00$, $a/c_i = 0.0312$
$a/t_i = 0.2$ - $G_i = G0$ - Run 113
$a/t_i = 0.2$ - $G_i = G1$ - Run 114
$a/t_i = 0.4$ - $G_i = G0$ - Run 115
$a/t_i = 0.4$ - $G_i = G1$ - Run 116
$a/t_i = 0.6$ - $G_i = G0$ - Run 117
$a/t_i = 0.6$ - $G_i = G1$ - Run 118
$a/t_i = 0.8$ - $G_i = G0$ - Run 119
$a/t_i = 0.8$ - $G_i = G1$ - Run 120
G
Normalized ϕ angle

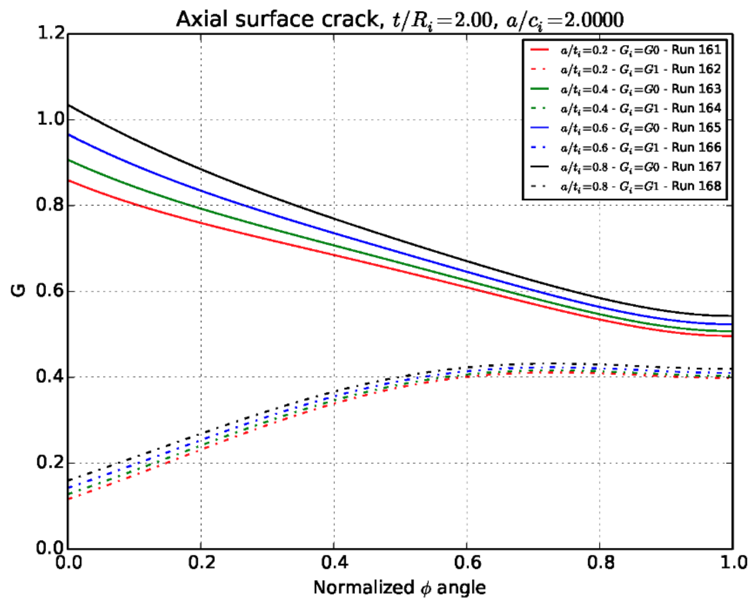

Axial surface crack, $t/R_i = 2.00$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 121
$a/t_i = 0.2$ - $G_i = G1$ - Run 122
$a/t_i = 0.4$ - $G_i = G0$ - Run 123
$a/t_i = 0.4$ - $G_i = G1$ - Run 124
$a/t_i = 0.6$ - $G_i = G0$ - Run 125
$a/t_i = 0.6$ - $G_i = G1$ - Run 126
$a/t_i = 0.8$ - $G_i = G0$ - Run 127
$a/t_i = 0.8$ - $G_i = G1$ - Run 128
G
Normalized ϕ angle

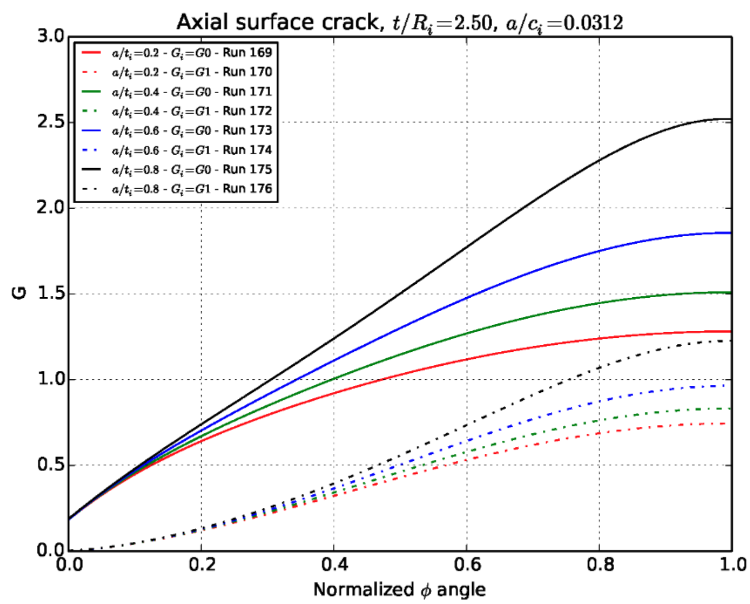

Axial surface crack, $t/R_i = 2.00$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 129
$a/t_i = 0.2$ - $G_i = G1$ - Run 130
$a/t_i = 0.4$ - $G_i = G0$ - Run 131
$a/t_i = 0.4$ - $G_i = G1$ - Run 132
$a/t_i = 0.6$ - $G_i = G0$ - Run 133
$a/t_i = 0.6$ - $G_i = G1$ - Run 134
$a/t_i = 0.8$ - $G_i = G0$ - Run 135
$a/t_i = 0.8$ - $G_i = G1$ - Run 136
G
Normalized ϕ angle

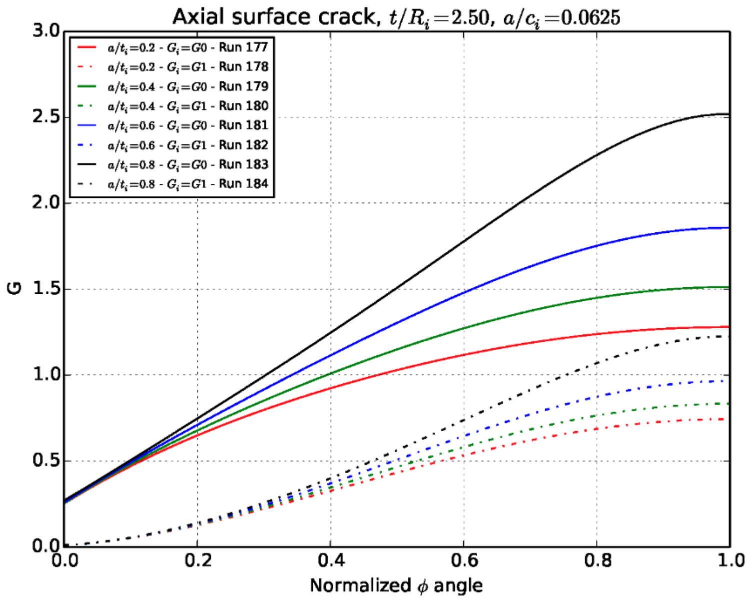

Axial surface crack, $t/R_i = 2.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 137
$a/t_i = 0.2$ - $G_i = G1$ - Run 138
$a/t_i = 0.4$ - $G_i = G0$ - Run 139
$a/t_i = 0.4$ - $G_i = G1$ - Run 140
$a/t_i = 0.6$ - $G_i = G0$ - Run 141
$a/t_i = 0.6$ - $G_i = G1$ - Run 142
$a/t_i = 0.8$ - $G_i = G0$ - Run 143
$a/t_i = 0.8$ - $G_i = G1$ - Run 144
G
Normalized ϕ angle

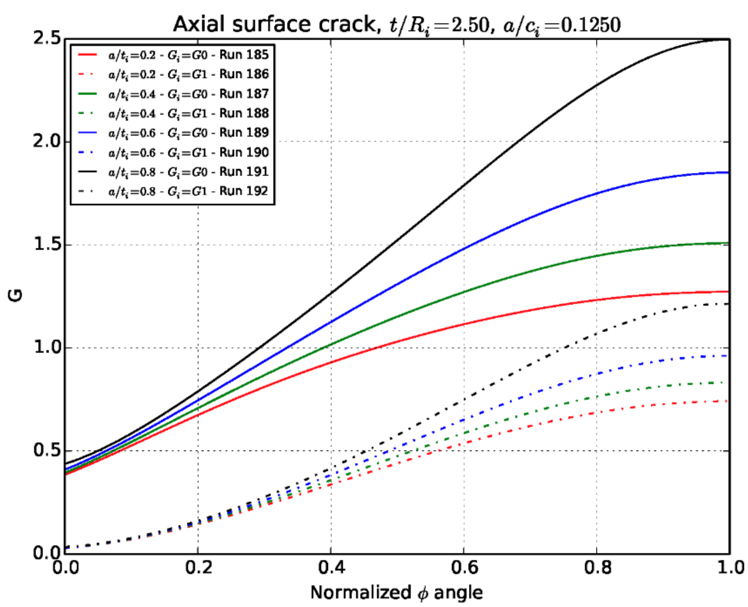

Axial surface crack, t/Ri=2.00, a/ci=0.5000
a/ti=0.2 - Gi=G0 - Run 145
a/ti=0.2 - Gi=G1 - Run 146
a/ti=0.4 - Gi=G0 - Run 147
a/ti=0.4 - Gi=G1 - Run 148
a/ti=0.6 - Gi=G0 - Run 149
a/ti=0.6 - Gi=G1 - Run 150
a/ti=0.8 - Gi=G0 - Run 151
a/ti=0.8 - Gi=G1 - Run 152
G
Normalized ϕ angle

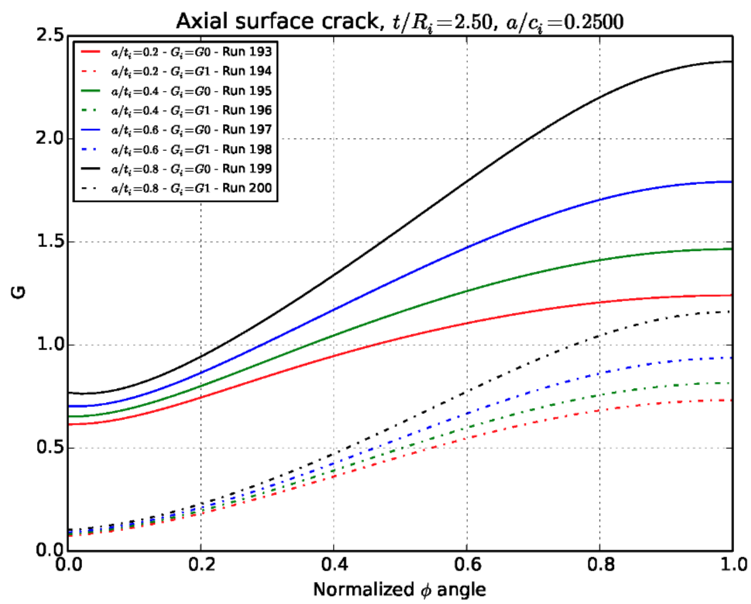

Axial surface crack, t/Ri=2.00, a/ci=1.0000
a/ti=0.2 - Gi=G0 - Run 153
a/ti=0.2 - Gi=G1 - Run 154
a/ti=0.4 - Gi=G0 - Run 155
a/ti=0.4 - Gi=G1 - Run 156
a/ti=0.6 - Gi=G0 - Run 157
a/ti=0.6 - Gi=G1 - Run 158
a/ti=0.8 - Gi=G0 - Run 159
a/ti=0.8 - Gi=G1 - Run 160
G
Normalized ϕ angle

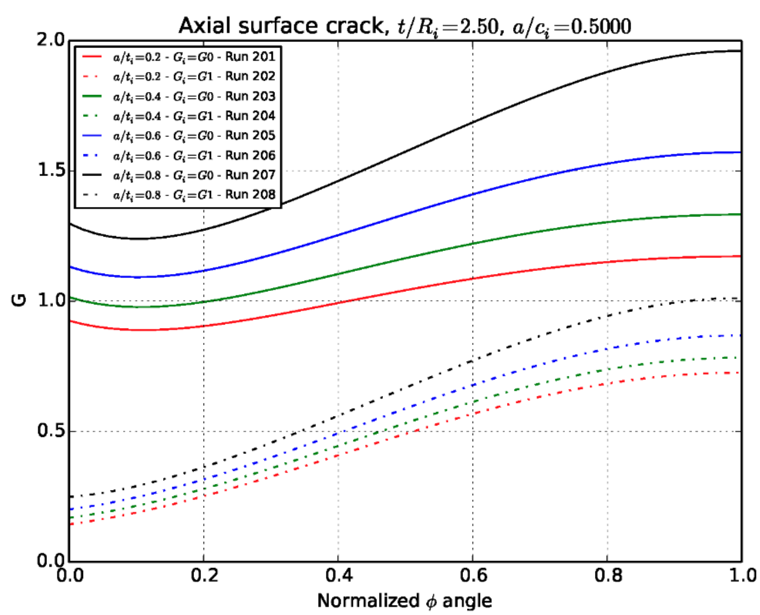

Axial surface crack, $t/R_i = 2.00$, $a/c_i = 2.0000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 161
$a/t_i = 0.2$ - $G_i = G1$ - Run 162
$a/t_i = 0.4$ - $G_i = G0$ - Run 163
$a/t_i = 0.4$ - $G_i = G1$ - Run 164
$a/t_i = 0.6$ - $G_i = G0$ - Run 165
$a/t_i = 0.6$ - $G_i = G1$ - Run 166
$a/t_i = 0.8$ - $G_i = G0$ - Run 167
$a/t_i = 0.8$ - $G_i = G1$ - Run 168
G
Normalized ϕ angle

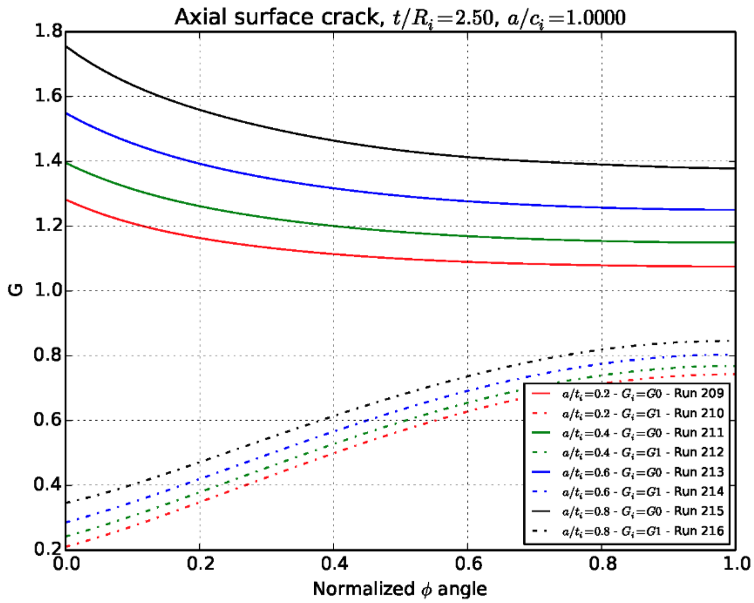

Axial surface crack, $t/R_i = 2.50$, $a/c_i = 0.0312$
$a/t_i = 0.2$ - $G_i = G0$ - Run 169
$a/t_i = 0.2$ - $G_i = G1$ - Run 170
$a/t_i = 0.4$ - $G_i = G0$ - Run 171
$a/t_i = 0.4$ - $G_i = G1$ - Run 172
$a/t_i = 0.6$ - $G_i = G0$ - Run 173
$a/t_i = 0.6$ - $G_i = G1$ - Run 174
$a/t_i = 0.8$ - $G_i = G0$ - Run 175
$a/t_i = 0.8$ - $G_i = G1$ - Run 176
G
Normalized ϕ angle

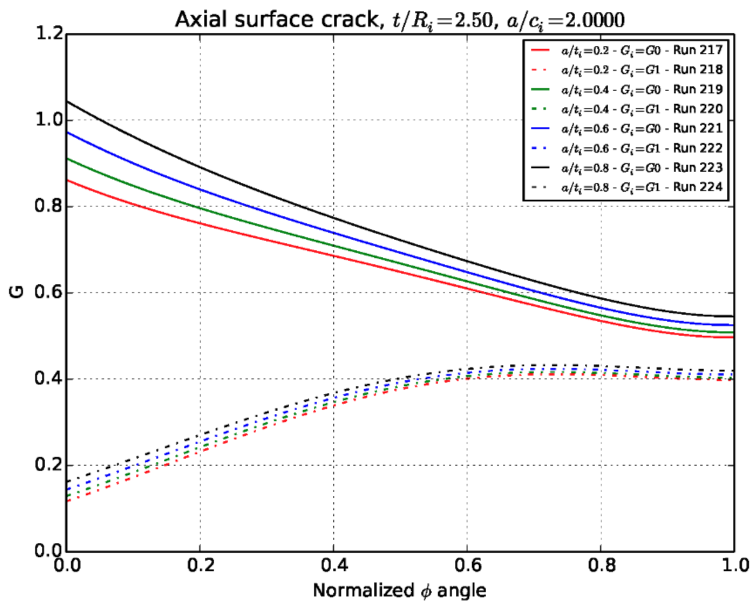

Axial surface crack, $t/R_i = 2.50$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 177
$a/t_i = 0.2$ - $G_i = G1$ - Run 178
$a/t_i = 0.4$ - $G_i = G0$ - Run 179
$a/t_i = 0.4$ - $G_i = G1$ - Run 180
$a/t_i = 0.6$ - $G_i = G0$ - Run 181
$a/t_i = 0.6$ - $G_i = G1$ - Run 182
$a/t_i = 0.8$ - $G_i = G0$ - Run 183
$a/t_i = 0.8$ - $G_i = G1$ - Run 184
G
Normalized ϕ angle

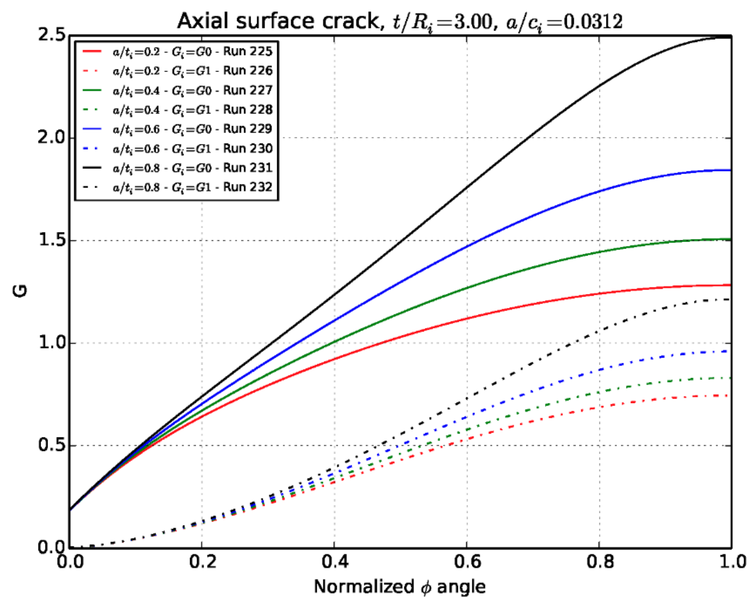

Axial surface crack, $t/R_i = 2.50$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 185
$a/t_i = 0.2$ - $G_i = G1$ - Run 186
$a/t_i = 0.4$ - $G_i = G0$ - Run 187
$a/t_i = 0.4$ - $G_i = G1$ - Run 188
$a/t_i = 0.6$ - $G_i = G0$ - Run 189
$a/t_i = 0.6$ - $G_i = G1$ - Run 190
$a/t_i = 0.8$ - $G_i = G0$ - Run 191
$a/t_i = 0.8$ - $G_i = G1$ - Run 192
G
Normalized ϕ angle


Axial surface crack, $t/R_i=2.50$, $a/c_i=0.2500$
$a/t_i=0.2$ - $G_i=G0$ - Run 193
$a/t_i=0.2$ - $G_i=G1$ - Run 194
$a/t_i=0.4$ - $G_i=G0$ - Run 195
$a/t_i=0.4$ - $G_i=G1$ - Run 196
$a/t_i=0.6$ - $G_i=G0$ - Run 197
$a/t_i=0.6$ - $G_i=G1$ - Run 198
$a/t_i=0.8$ - $G_i=G0$ - Run 199
$a/t_i=0.8$ - $G_i=G1$ - Run 200
G
Normalized ϕ angle

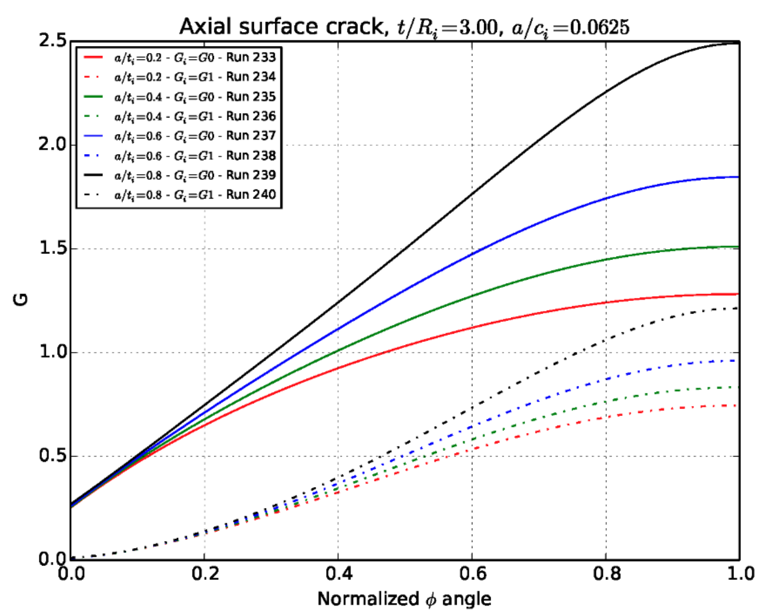

Axial surface crack, $t/R_i=2.50$, $a/c_i=0.5000$
$a/t_i=0.2$ - $G_i=G0$ - Run 201
$a/t_i=0.2$ - $G_i=G1$ - Run 202
$a/t_i=0.4$ - $G_i=G0$ - Run 203
$a/t_i=0.4$ - $G_i=G1$ - Run 204
$a/t_i=0.6$ - $G_i=G0$ - Run 205
$a/t_i=0.6$ - $G_i=G1$ - Run 206
$a/t_i=0.8$ - $G_i=G0$ - Run 207
$a/t_i=0.8$ - $G_i=G1$ - Run 208
G
Normalized ϕ angle


Axial surface crack, $t/R_i=2.50$, $a/c_i=1.0000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G0$ - Run 209
$a/t_i=0.2$ - $G_i=G1$ - Run 210
$a/t_i=0.4$ - $G_i=G0$ - Run 211
$a/t_i=0.4$ - $G_i=G1$ - Run 212
$a/t_i=0.6$ - $G_i=G0$ - Run 213
$a/t_i=0.6$ - $G_i=G1$ - Run 214
$a/t_i=0.8$ - $G_i=G0$ - Run 215
$a/t_i=0.8$ - $G_i=G1$ - Run 216

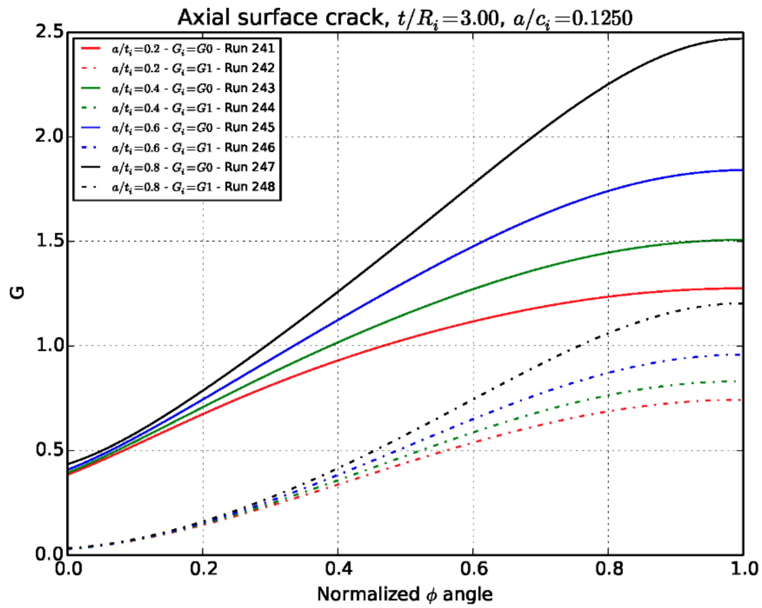

Axial surface crack, $t/R_i=2.50$, $a/c_i=2.0000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G0$ - Run 217
$a/t_i=0.2$ - $G_i=G1$ - Run 218
$a/t_i=0.4$ - $G_i=G0$ - Run 219
$a/t_i=0.4$ - $G_i=G1$ - Run 220
$a/t_i=0.6$ - $G_i=G0$ - Run 221
$a/t_i=0.6$ - $G_i=G1$ - Run 222
$a/t_i=0.8$ - $G_i=G0$ - Run 223
$a/t_i=0.8$ - $G_i=G1$ - Run 224

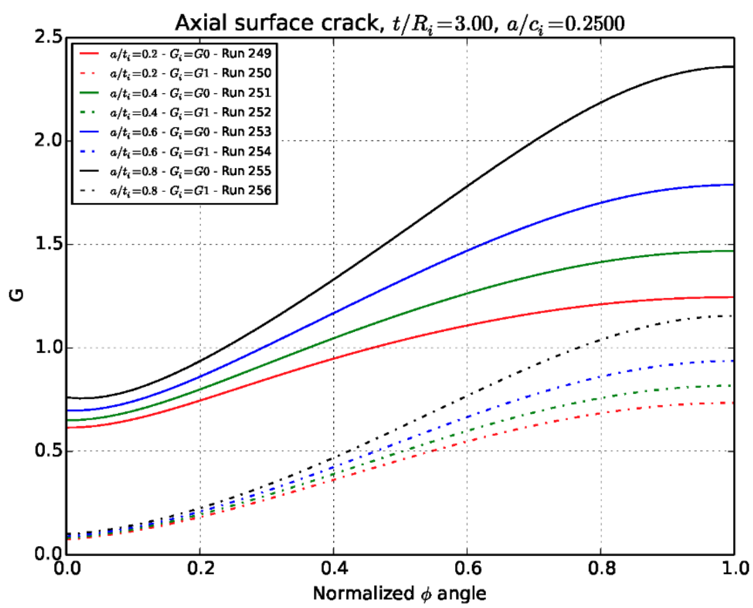


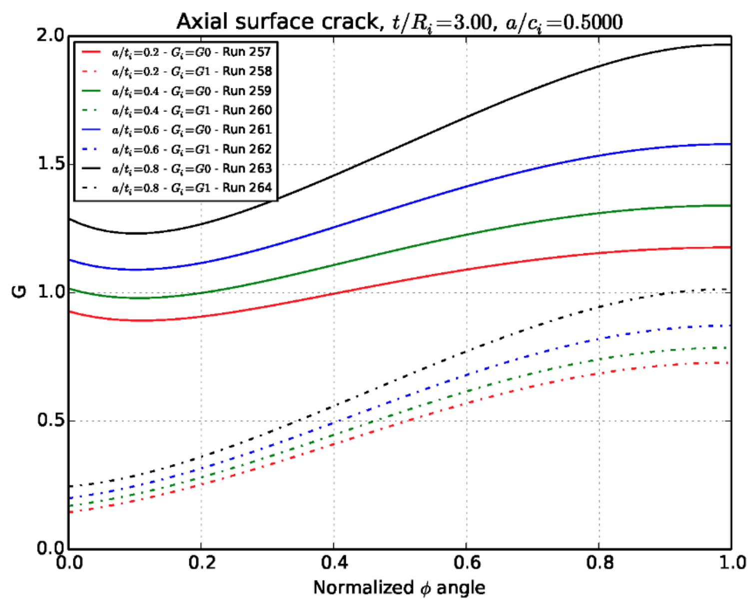
Axial surface crack, $t/R_i = 3.00$, $a/c_i = 0.0312$
$a/t_i = 0.2$ - $G_i = G0$ - Run 225
$a/t_i = 0.2$ - $G_i = G1$ - Run 226
$a/t_i = 0.4$ - $G_i = G0$ - Run 227
$a/t_i = 0.4$ - $G_i = G1$ - Run 228
$a/t_i = 0.6$ - $G_i = G0$ - Run 229
$a/t_i = 0.6$ - $G_i = G1$ - Run 230
$a/t_i = 0.8$ - $G_i = G0$ - Run 231
$a/t_i = 0.8$ - $G_i = G1$ - Run 232
G
Normalized ϕ angle

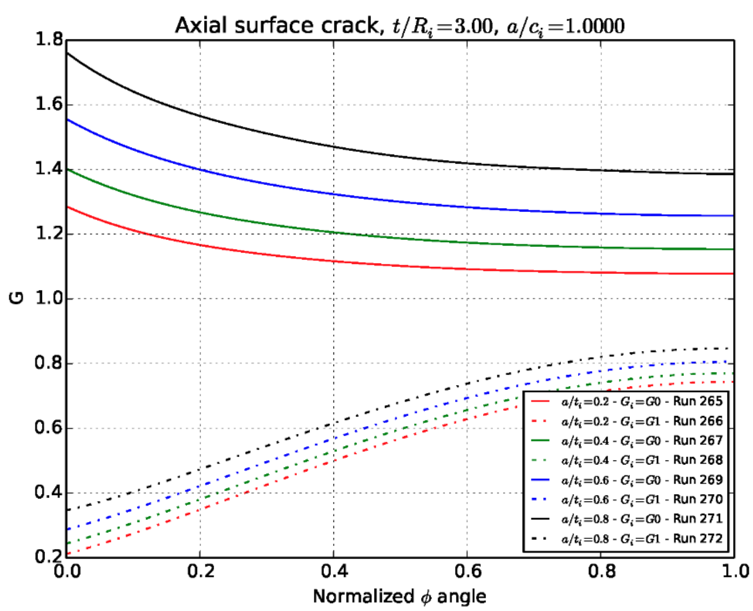


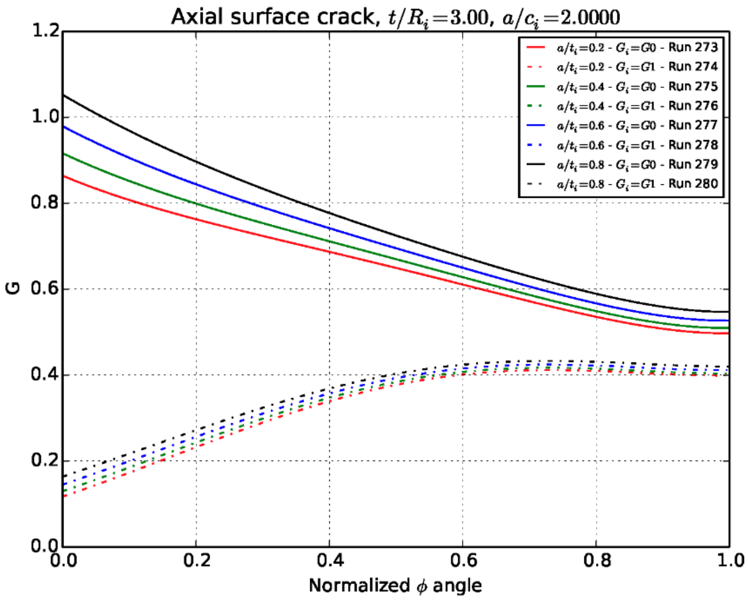
Axial surface crack, $t/R_i = 3.00$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 233
$a/t_i = 0.2$ - $G_i = G1$ - Run 234
$a/t_i = 0.4$ - $G_i = G0$ - Run 235
$a/t_i = 0.4$ - $G_i = G1$ - Run 236
$a/t_i = 0.6$ - $G_i = G0$ - Run 237
$a/t_i = 0.6$ - $G_i = G1$ - Run 238
$a/t_i = 0.8$ - $G_i = G0$ - Run 239
$a/t_i = 0.8$ - $G_i = G1$ - Run 240
G
Normalized ϕ angle


Axial surface crack, $t/R_i = 3.00$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 241
$a/t_i = 0.2$ - $G_i = G1$ - Run 242
$a/t_i = 0.4$ - $G_i = G0$ - Run 243
$a/t_i = 0.4$ - $G_i = G1$ - Run 244
$a/t_i = 0.6$ - $G_i = G0$ - Run 245
$a/t_i = 0.6$ - $G_i = G1$ - Run 246
$a/t_i = 0.8$ - $G_i = G0$ - Run 247
$a/t_i = 0.8$ - $G_i = G1$ - Run 248
G
Normalized ϕ angle


Axial surface crack, $t/R_i = 3.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 249
$a/t_i = 0.2$ - $G_i = G1$ - Run 250
$a/t_i = 0.4$ - $G_i = G0$ - Run 251
$a/t_i = 0.4$ - $G_i = G1$ - Run 252
$a/t_i = 0.6$ - $G_i = G0$ - Run 253
$a/t_i = 0.6$ - $G_i = G1$ - Run 254
$a/t_i = 0.8$ - $G_i = G0$ - Run 255
$a/t_i = 0.8$ - $G_i = G1$ - Run 256
G
Normalized ϕ angle

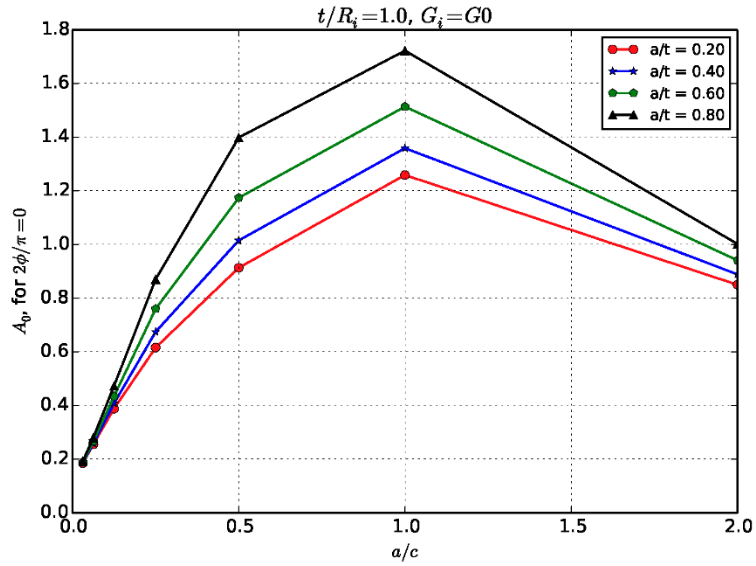

Axial surface crack, $t/R_i = 3.00$, $a/c_i = 0.5000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 257
$a/t_i = 0.2$ - $G_i = G1$ - Run 258
$a/t_i = 0.4$ - $G_i = G0$ - Run 259
$a/t_i = 0.4$ - $G_i = G1$ - Run 260
$a/t_i = 0.6$ - $G_i = G0$ - Run 261
$a/t_i = 0.6$ - $G_i = G1$ - Run 262
$a/t_i = 0.8$ - $G_i = G0$ - Run 263
$a/t_i = 0.8$ - $G_i = G1$ - Run 264
G
Normalized ϕ angle

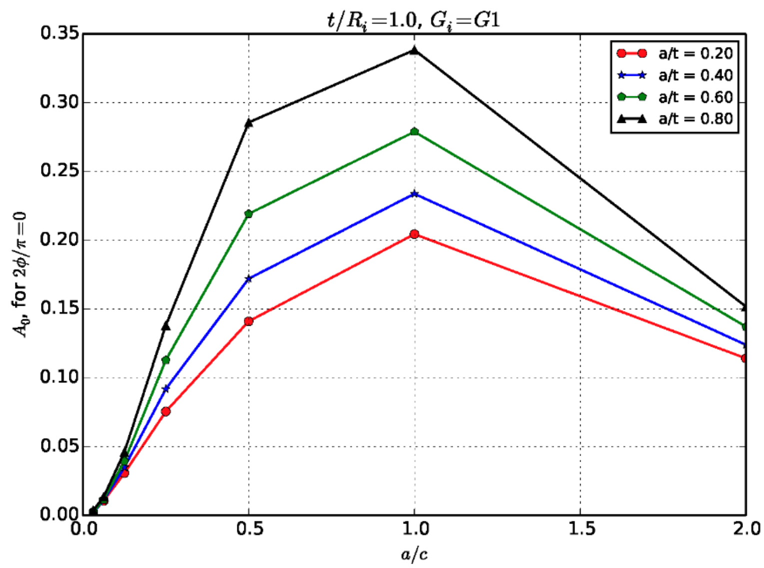

Axial surface crack, $t/R_i = 3.00$, $a/c_i = 1.0000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 265
$a/t_i = 0.2$ - $G_i = G1$ - Run 266
$a/t_i = 0.4$ - $G_i = G0$ - Run 267
$a/t_i = 0.4$ - $G_i = G1$ - Run 268
$a/t_i = 0.6$ - $G_i = G0$ - Run 269
$a/t_i = 0.6$ - $G_i = G1$ - Run 270
$a/t_i = 0.8$ - $G_i = G0$ - Run 271
$a/t_i = 0.8$ - $G_i = G1$ - Run 272
G
Normalized ϕ angle

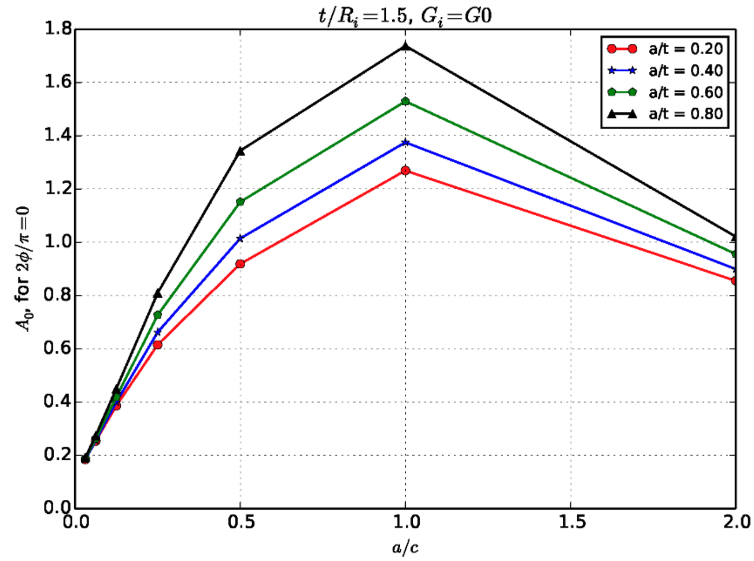

Axial surface crack, $t/R_i = 3.00$, $a/c_i = 2.0000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 273
$a/t_i = 0.2$ - $G_i = G1$ - Run 274
$a/t_i = 0.4$ - $G_i = G0$ - Run 275
$a/t_i = 0.4$ - $G_i = G1$ - Run 276
$a/t_i = 0.6$ - $G_i = G0$ - Run 277
$a/t_i = 0.6$ - $G_i = G1$ - Run 278
$a/t_i = 0.8$ - $G_i = G0$ - Run 279
$a/t_i = 0.8$ - $G_i = G1$ - Run 280
G
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

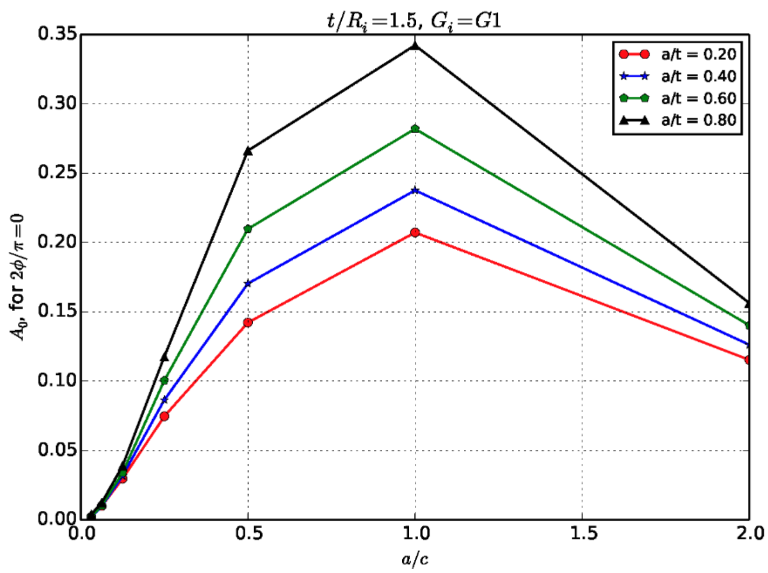
APPENDIX F: AXIAL EXTERNAL SURFACE CRACK TREND PLOTS

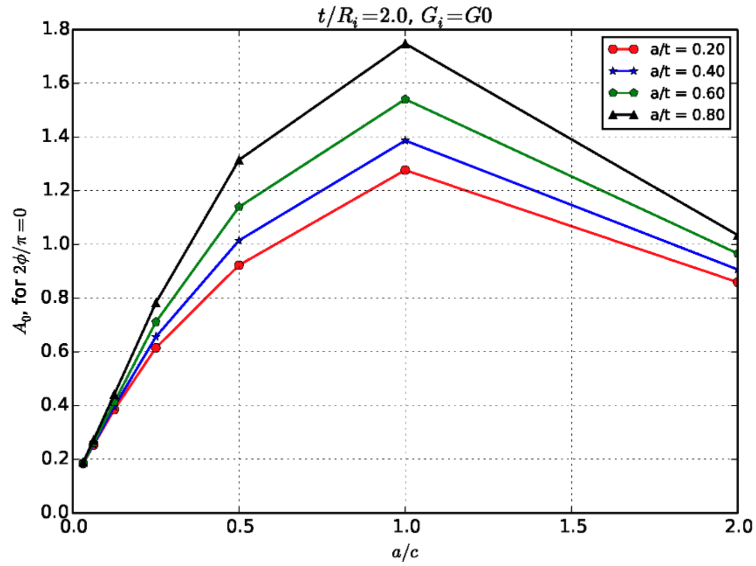
Plots to compare G result trends at the crack tip (at $2\phi/\pi = 0$) and at the crack depth (at $2\phi/\pi = 1$) for the axial external surface cracks. Four curves per plot for each a/t ratio; 20 plots total. At the crack tip, plot the $G = A_0$ curve-fit coefficient versus the a/c ratio; see the first 10 plots. At the crack depth, plot the sum of the curve-fit coefficient values: $G = \Sigma A_i$; see the last 10 plots.

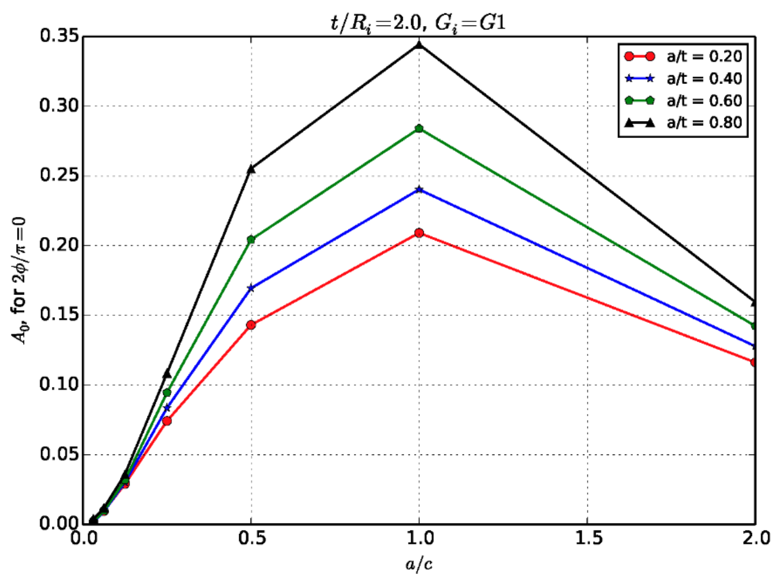


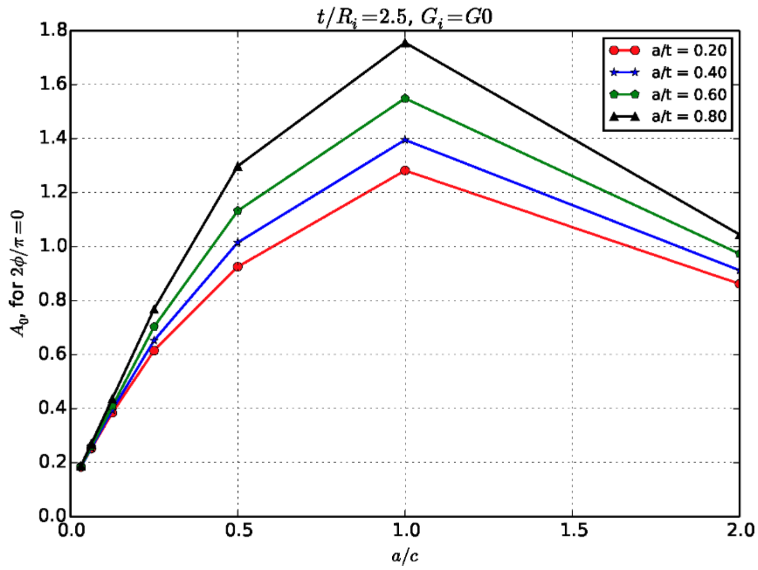


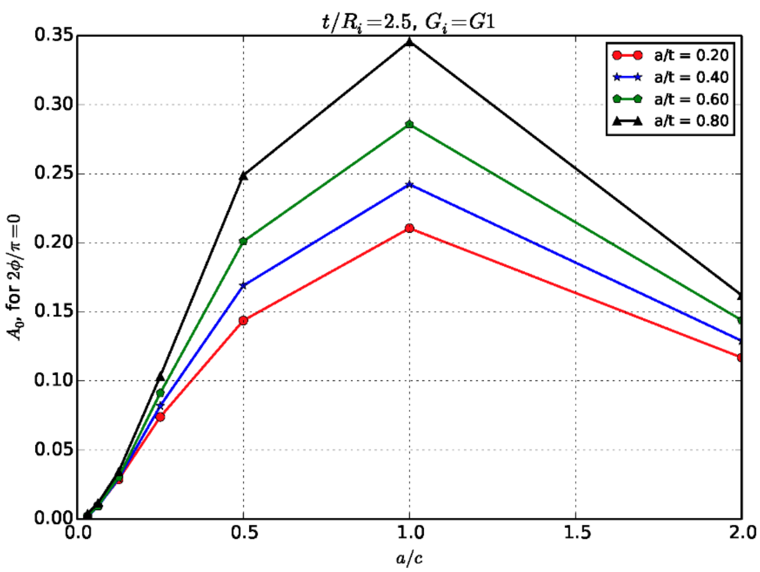

$t/R_i = 1.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

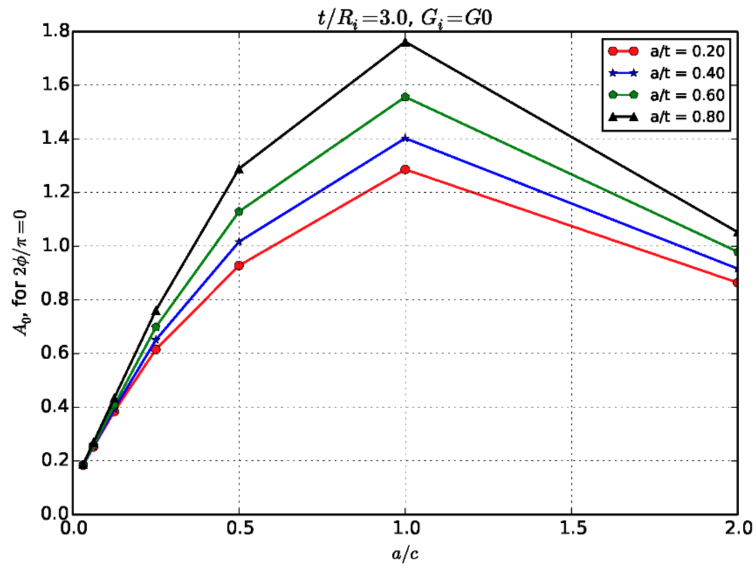

$t/R_i = 1.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

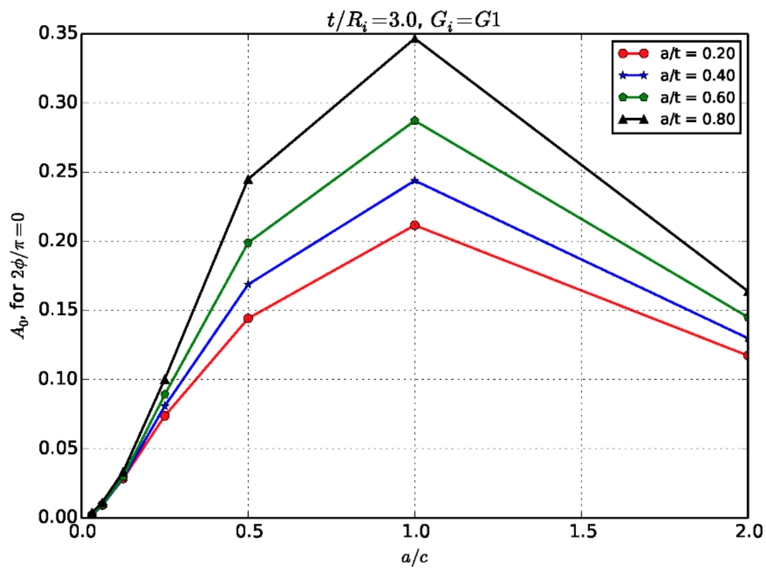

$t/R_i = 2.0$, $G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0

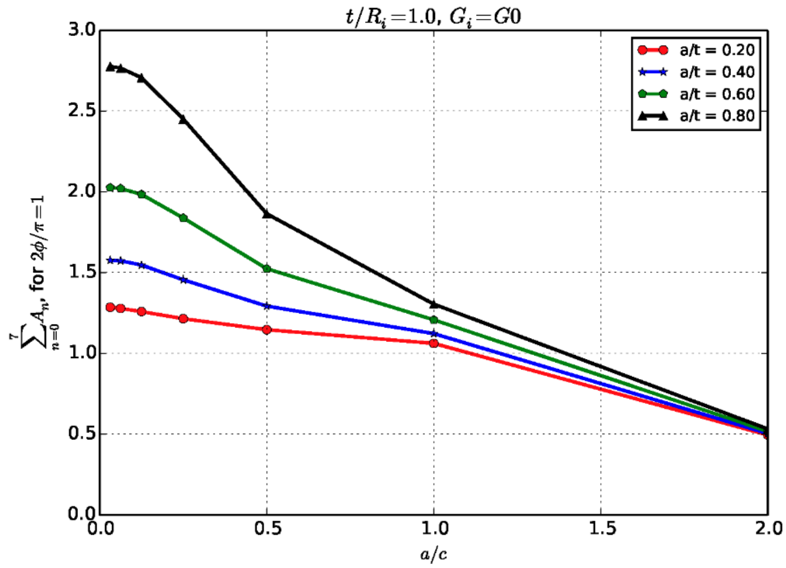

$t/R_i = 2.0$, $G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0

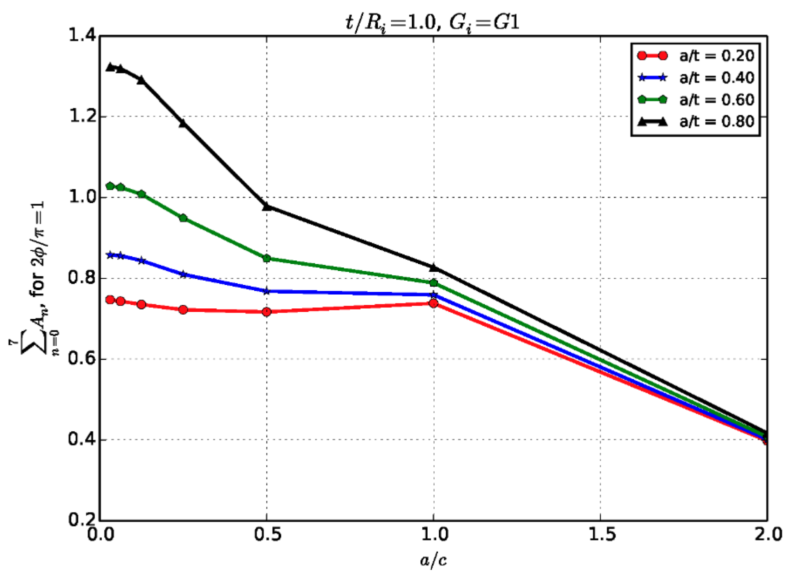

$t/R_i = 2.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.0
0.5
1.0
1.5
2.0

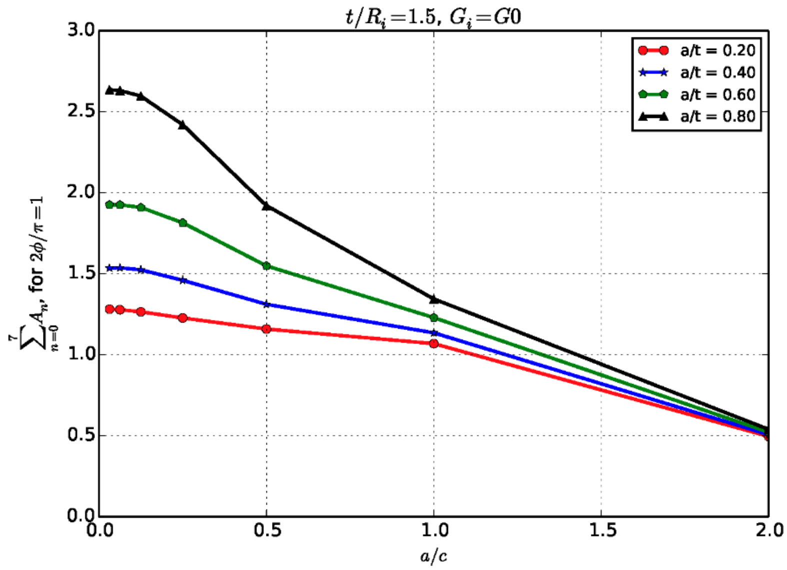

$t/R_i = 2.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.0
0.5
1.0
1.5
2.0

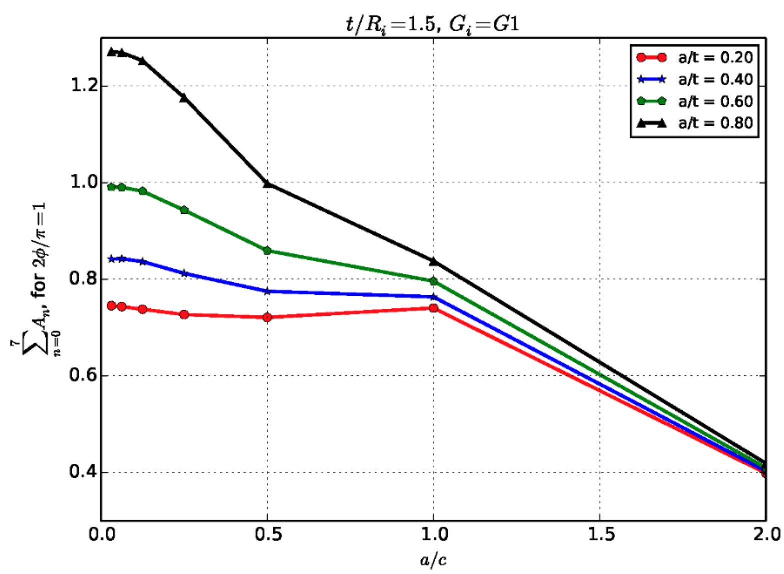

$t/R_i = 3.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.0
0.5
1.0
1.5
2.0

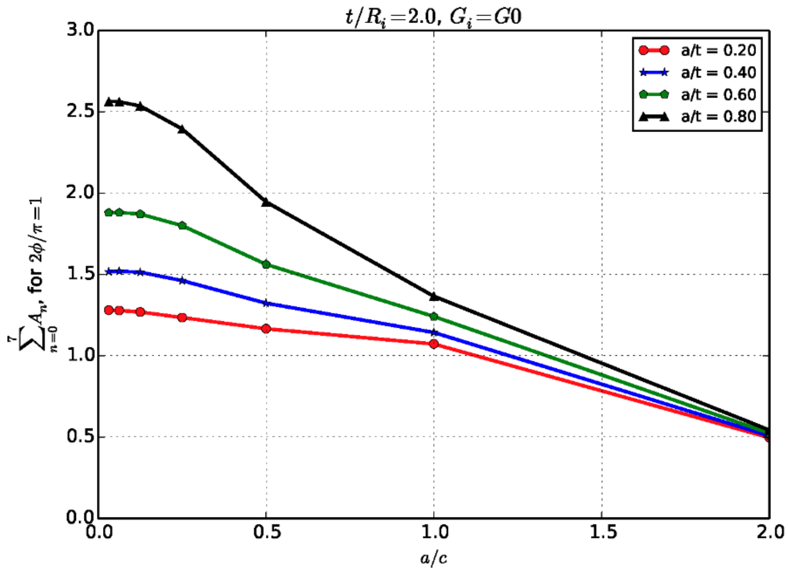

$t/R_i = 3.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.0
0.5
1.0
1.5
2.0

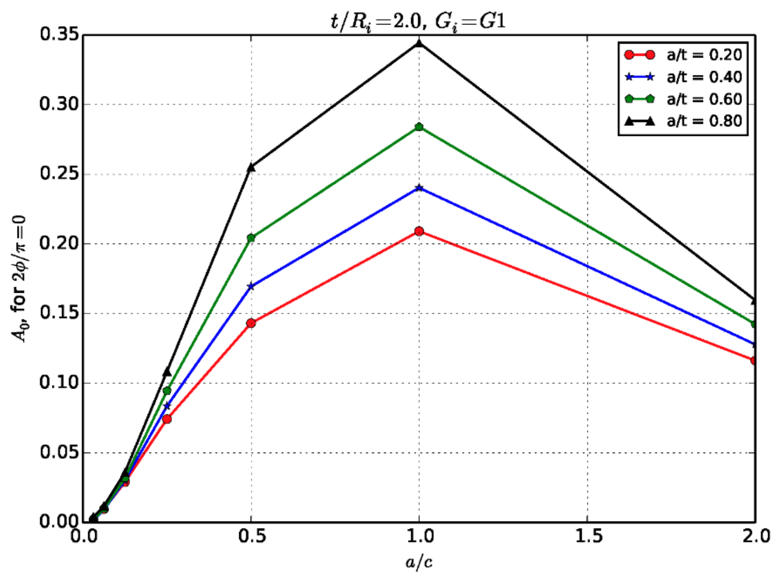

$t/R_i = 1.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.0
0.5
1.0
1.5
2.0
2.5
3.0

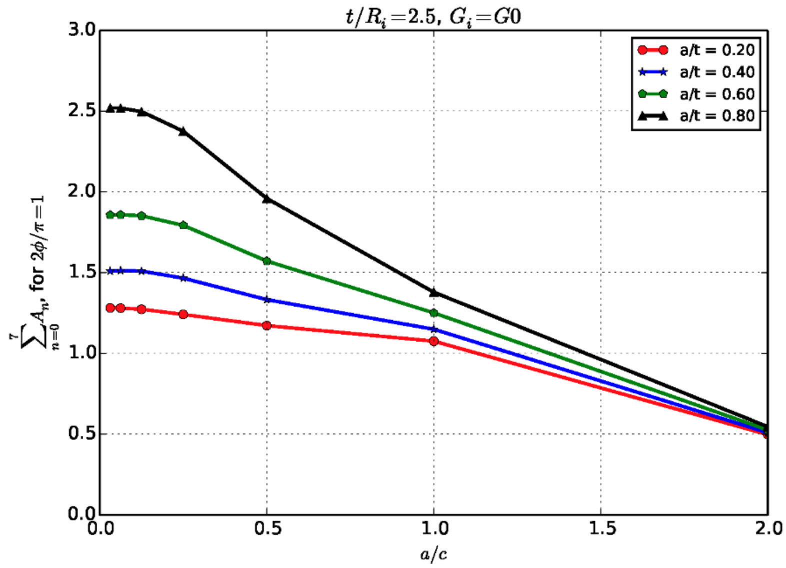

$t/R_i = 1.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.5
1.0
1.5
2.0

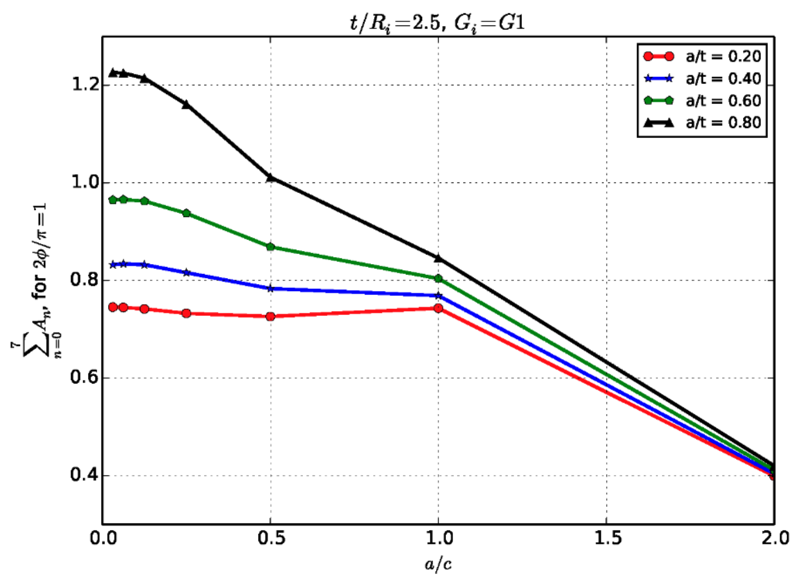

$t/R_i = 1.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

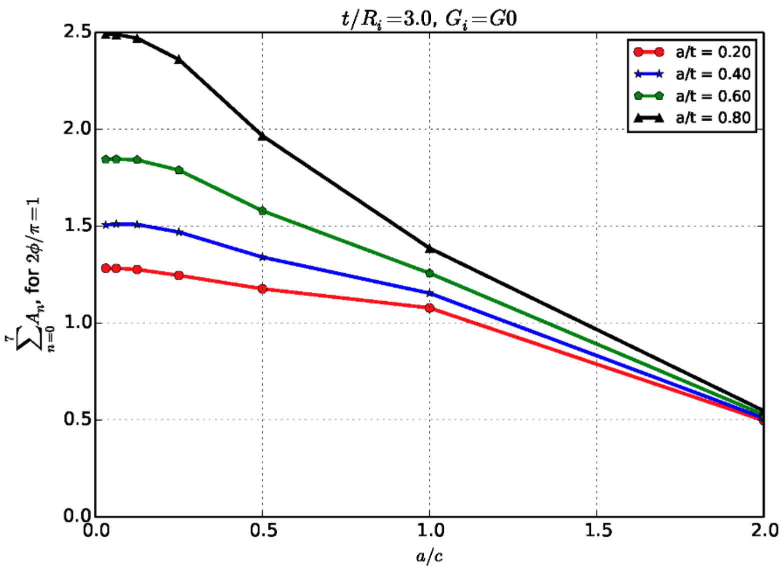

$t/R_i = 1.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
1.2
1.0
0.8
0.6
0.4
0.0
0.5
1.0
1.5
2.0

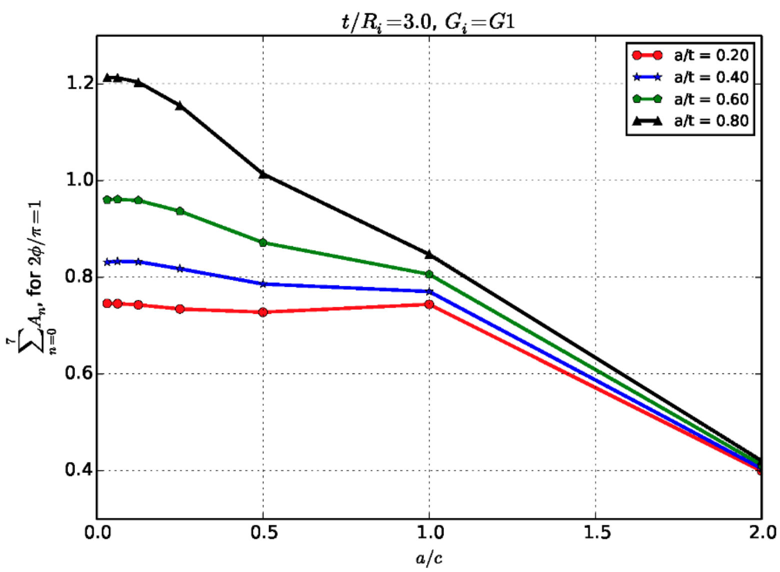

$t/R_i = 2.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c


$t/R_i = 2.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c


$t/R_i = 2.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c

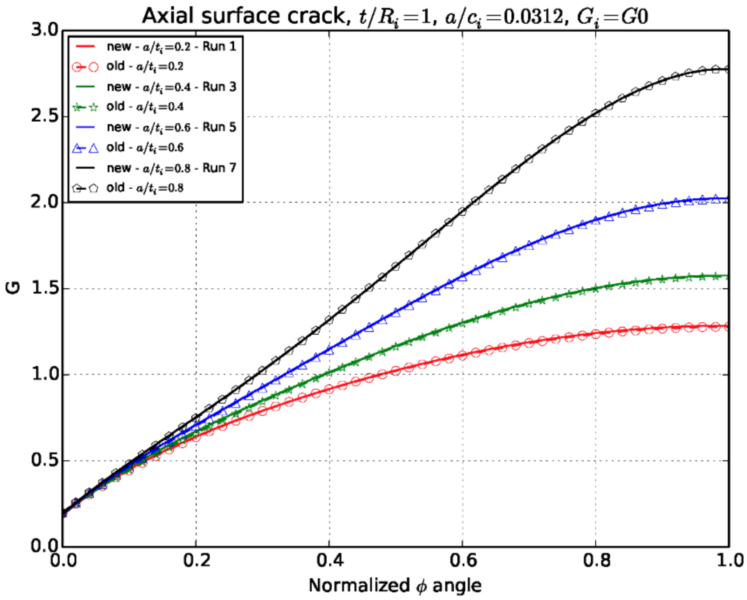

$t/R_i = 2.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c

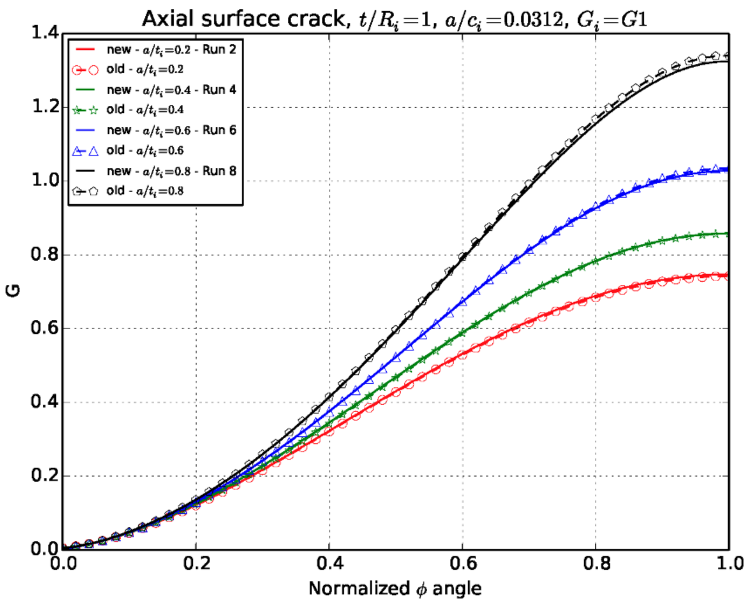

$t/R_i = 3.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.0
0.5
1.0
1.5
2.0
2.5

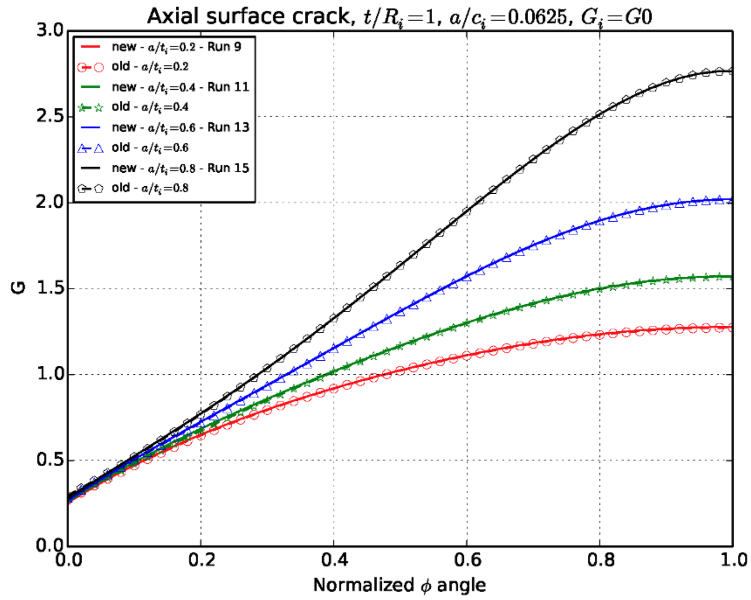

$t/R_i = 3.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.4
0.6
0.8
1.0
1.2
0.0
0.5
1.0
1.5
2.0

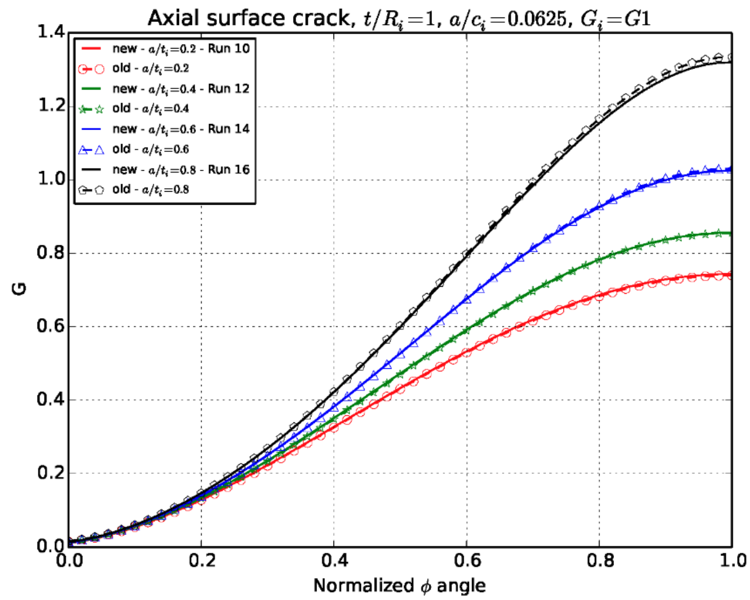
APPENDIX G: AXIAL EXTERNAL SURFACE COMPARISON TO PREVIOUS RESULTS

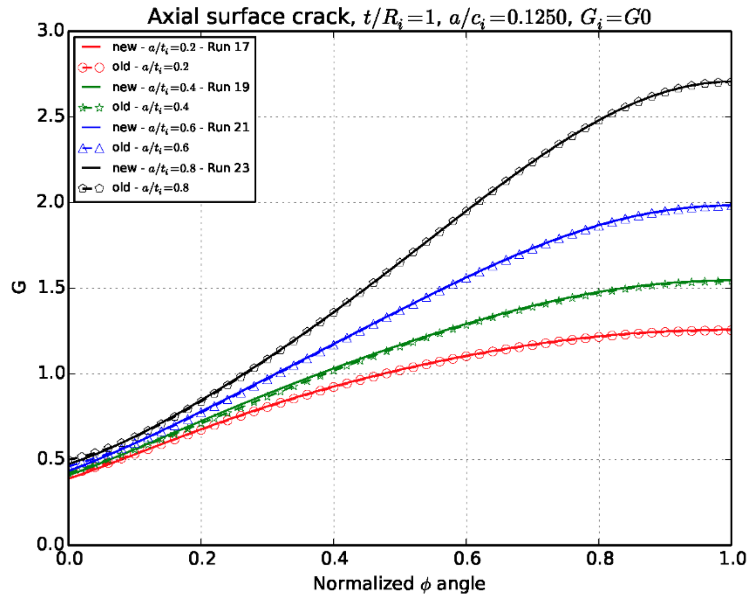
Plots to compare G results for the t/Ri=1 ratio from the previous results to the new results for the axial external surface cracks. The previous results were obtained from API 579, Annex C, Table C.13 [1]. Plot curves with data points and dashed lines show the previous results, and plot curves with solid lines show the new results; 14 plots total. Generally good agreement; the new results are an improvement with more mesh refinement.

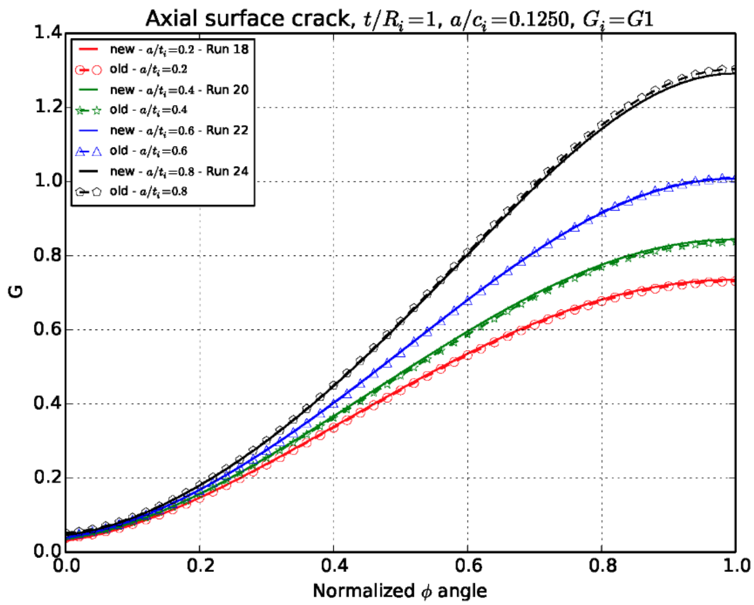


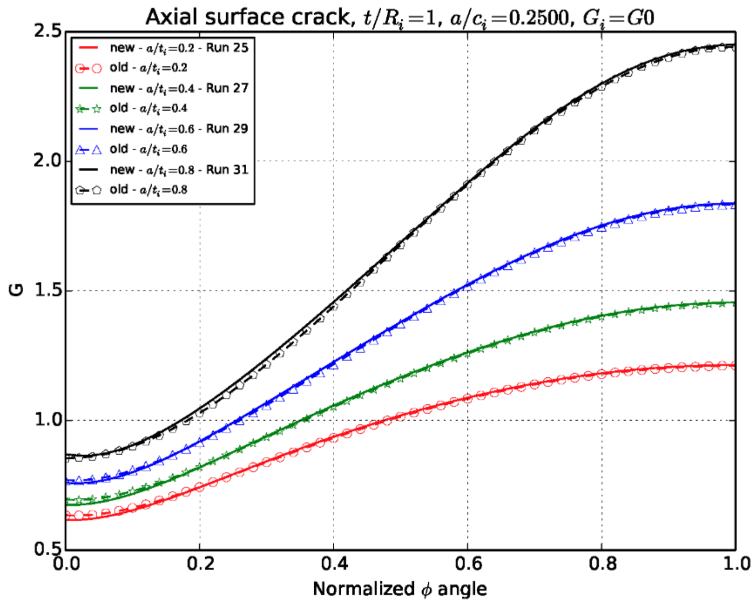


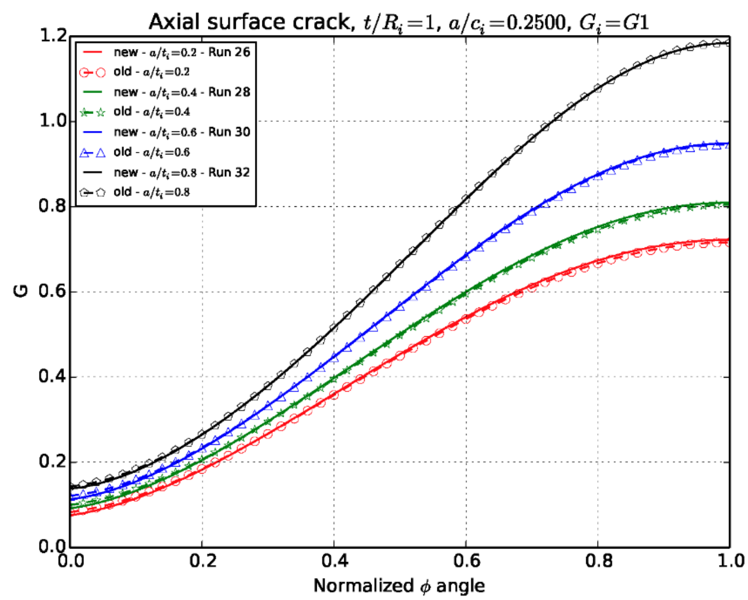

Axial surface crack, $t/R_i = 1$, $a/c_i = 0.0625$, $G_i = G0$
new - a/t_i=0.2 - Run 9
old - a/t_i=0.2
new - a/t_i=0.4 - Run 11
old - a/t_i=0.4
new - a/t_i=0.6 - Run 13
old - a/t_i=0.6
new - a/t_i=0.8 - Run 15
old - a/t_i=0.8
G
Normalized ϕ angle

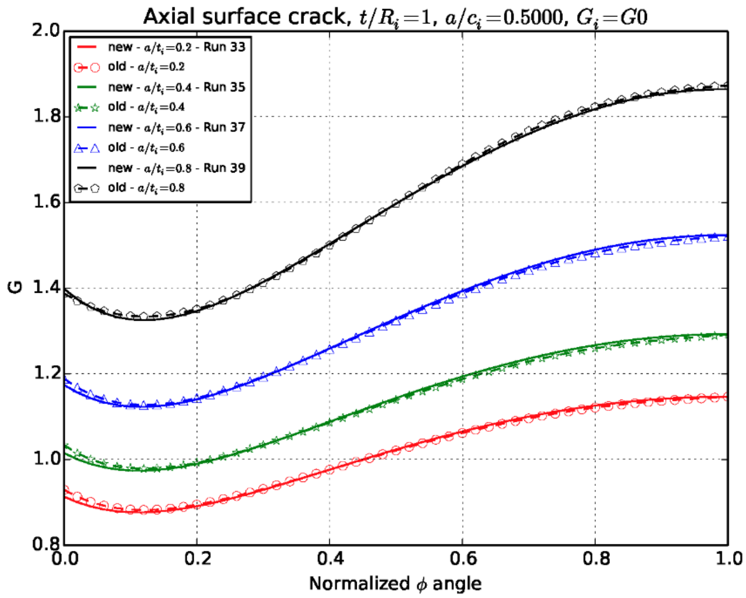

Axial surface crack, $t/R_i = 1$, $a/c_i = 0.0625$, $G_i = G1$
new - a/t_i=0.2 - Run 10
old - a/t_i=0.2
new - a/t_i=0.4 - Run 12
old - a/t_i=0.4
new - a/t_i=0.6 - Run 14
old - a/t_i=0.6
new - a/t_i=0.8 - Run 16
old - a/t_i=0.8
G
Normalized ϕ angle

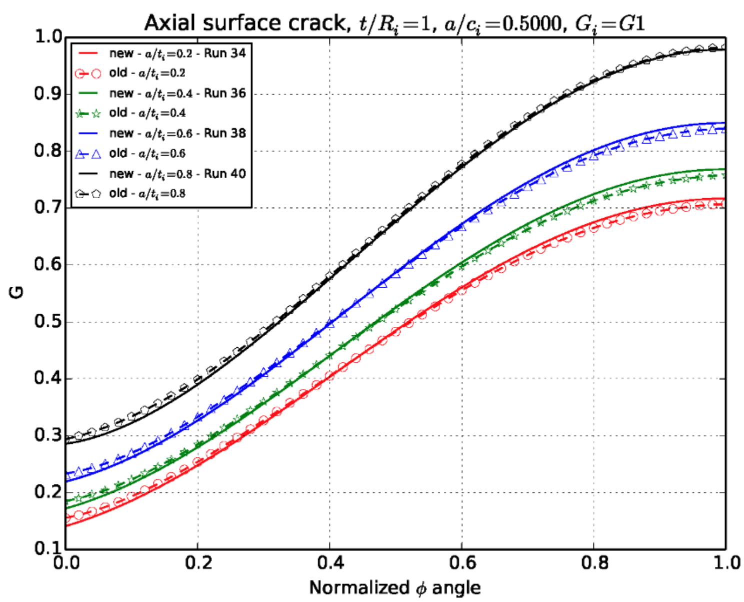

Axial surface crack, $t/R_i=1$, $a/c_i=0.1250$, $G_i=G0$
new - $a/t_i=0.2$ - Run 17
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 19
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 21
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 23
old - $a/t_i=0.8$
G
Normalized ϕ angle

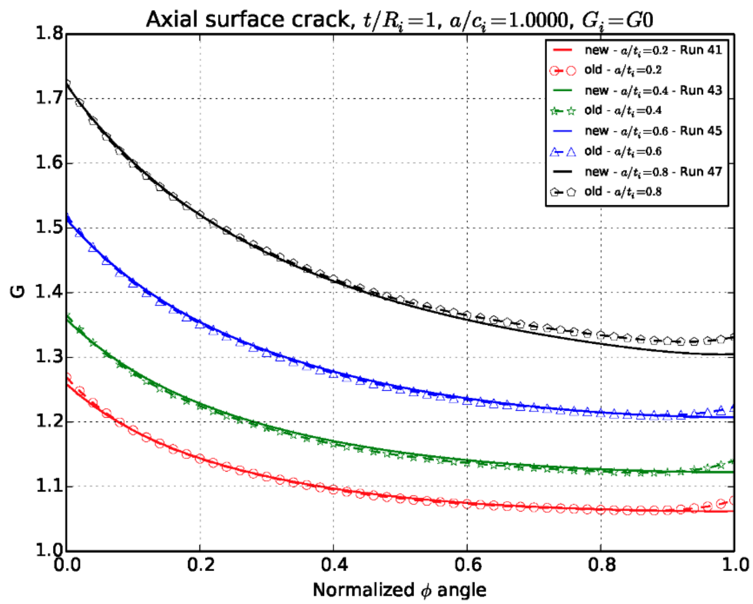

Axial surface crack, $t/R_i=1$, $a/c_i=0.1250$, $G_i=G1$
new - $a/t_i=0.2$ - Run 18
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 20
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 22
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 24
old - $a/t_i=0.8$
G
Normalized ϕ angle

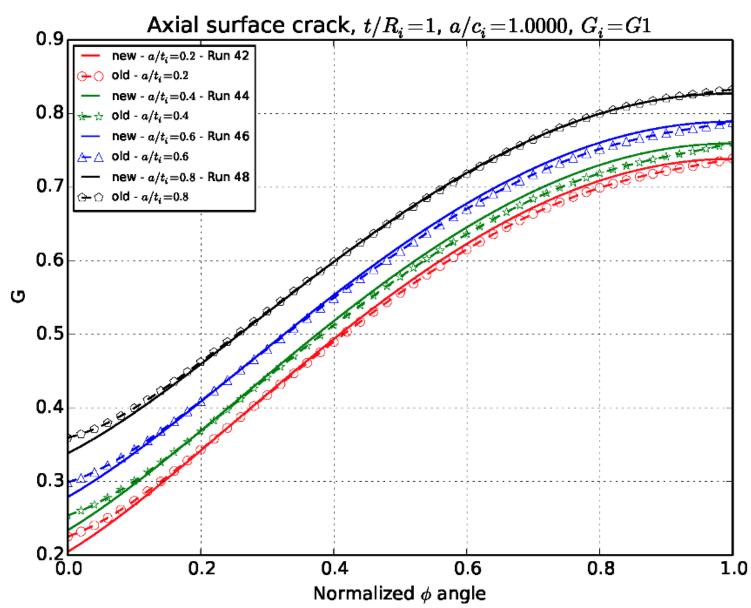

Axial surface crack, $t/R_i=1$, $a/c_i=0.2500$, $G_i=G0$
new - a/t_i=0.2 - Run 25
old - a/t_i=0.2
new - a/t_i=0.4 - Run 27
old - a/t_i=0.4
new - a/t_i=0.6 - Run 29
old - a/t_i=0.6
new - a/t_i=0.8 - Run 31
old - a/t_i=0.8
G
Normalized ϕ angle

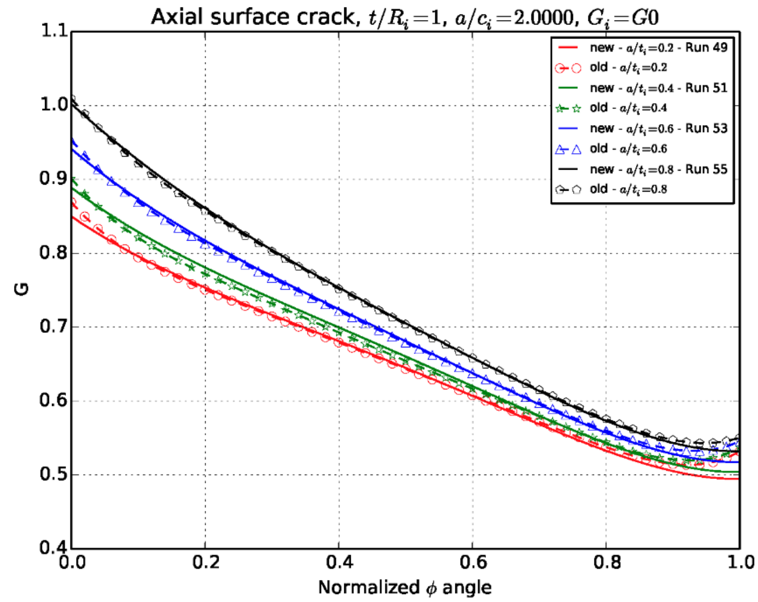

Axial surface crack, $t/R_i=1$, $a/c_i=0.2500$, $G_i=G1$
new - a/t_i=0.2 - Run 26
old - a/t_i=0.2
new - a/t_i=0.4 - Run 28
old - a/t_i=0.4
new - a/t_i=0.6 - Run 30
old - a/t_i=0.6
new - a/t_i=0.8 - Run 32
old - a/t_i=0.8
G
Normalized ϕ angle


Axial surface crack, $t/R_i = 1$, $a/c_i = 0.5000$, $G_i = G0$
new - a/t_i=0.2 - Run 33
old - a/t_i=0.2
new - a/t_i=0.4 - Run 35
old - a/t_i=0.4
new - a/t_i=0.6 - Run 37
old - a/t_i=0.6
new - a/t_i=0.8 - Run 39
old - a/t_i=0.8
G
Normalized ϕ angle

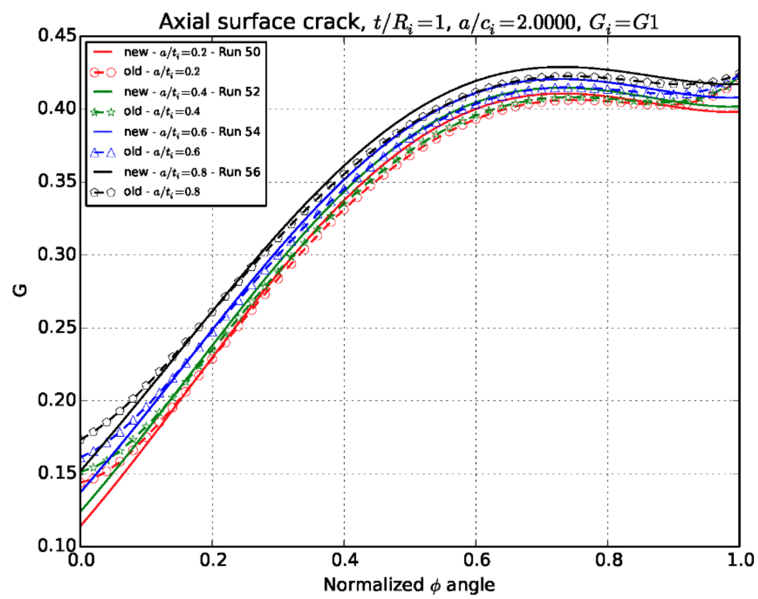

Axial surface crack, $t/R_i = 1$, $a/c_i = 0.5000$, $G_i = G1$
new - a/t_i=0.2 - Run 34
old - a/t_i=0.2
new - a/t_i=0.4 - Run 36
old - a/t_i=0.4
new - a/t_i=0.6 - Run 38
old - a/t_i=0.6
new - a/t_i=0.8 - Run 40
old - a/t_i=0.8
G
Normalized ϕ angle


Axial surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G0$
new - a/t_i=0.2 - Run 41
old - a/t_i=0.2
new - a/t_i=0.4 - Run 43
old - a/t_i=0.4
new - a/t_i=0.6 - Run 45
old - a/t_i=0.6
new - a/t_i=0.8 - Run 47
old - a/t_i=0.8
G
Normalized ϕ angle


Axial surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G1$
new - a/t_i=0.2 - Run 42
old - a/t_i=0.2
new - a/t_i=0.4 - Run 44
old - a/t_i=0.4
new - a/t_i=0.6 - Run 46
old - a/t_i=0.6
new - a/t_i=0.8 - Run 48
old - a/t_i=0.8
G
Normalized ϕ angle



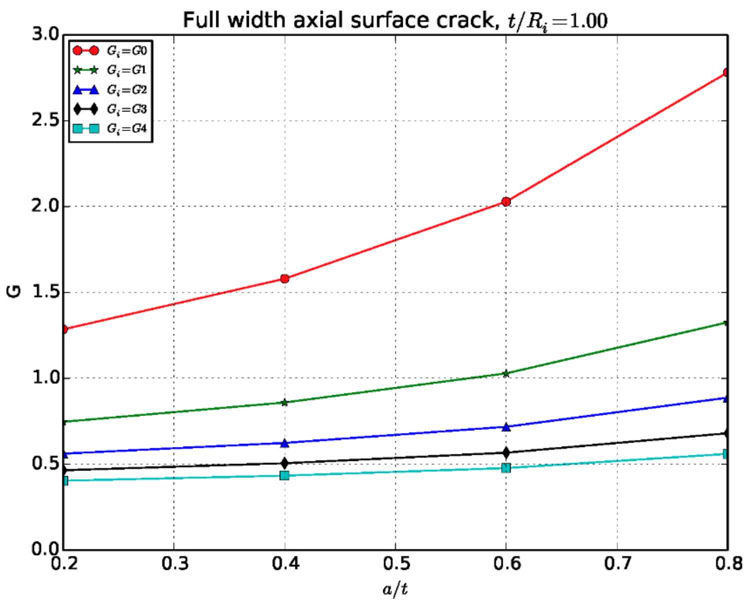
Axial surface crack, $t/R_i=1$, $a/c_i=2.0000$, $G_i=G0$
new - $a/t_i=0.2$ - Run 49
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 51
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 53
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 55
old - $a/t_i=0.8$
G
Normalized ϕ angle

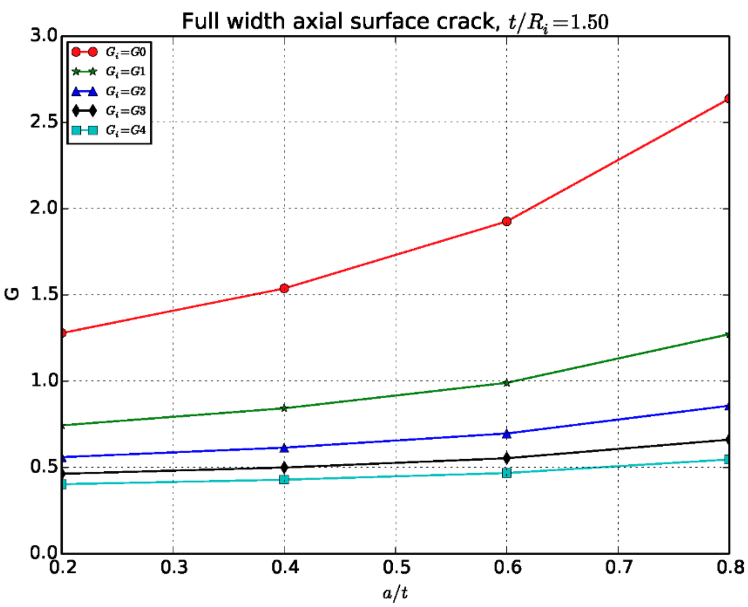


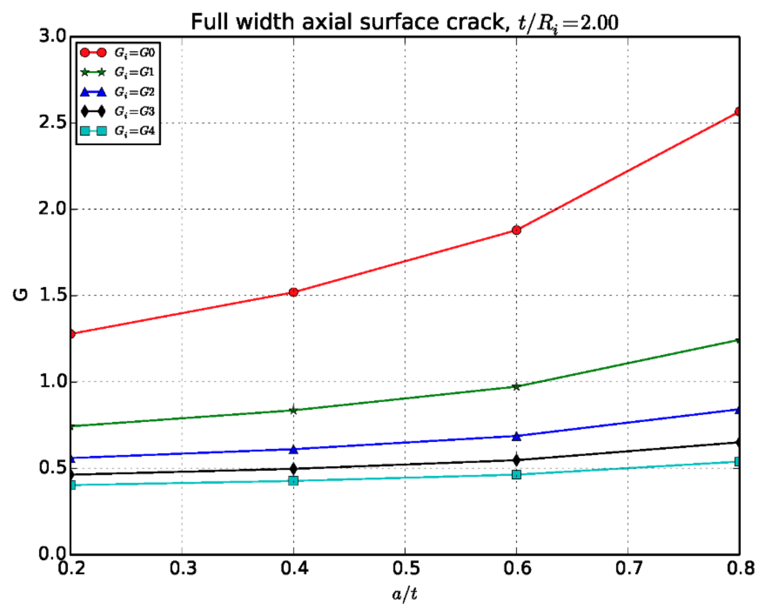
Axial surface crack, $t/R_i=1$, $a/c_i=2.0000$, $G_i=G1$
new - $a/t_i=0.2$ - Run 50
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 52
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 54
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 56
old - $a/t_i=0.8$
G
Normalized ϕ angle

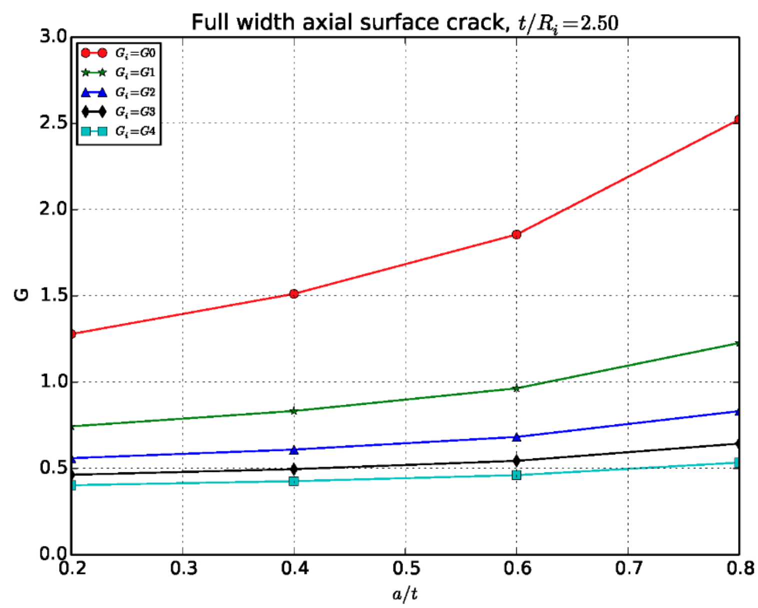
APPENDIX H: AXIAL EXTERNAL FULL-WIDTH CRACK G RESULTS PLOTS

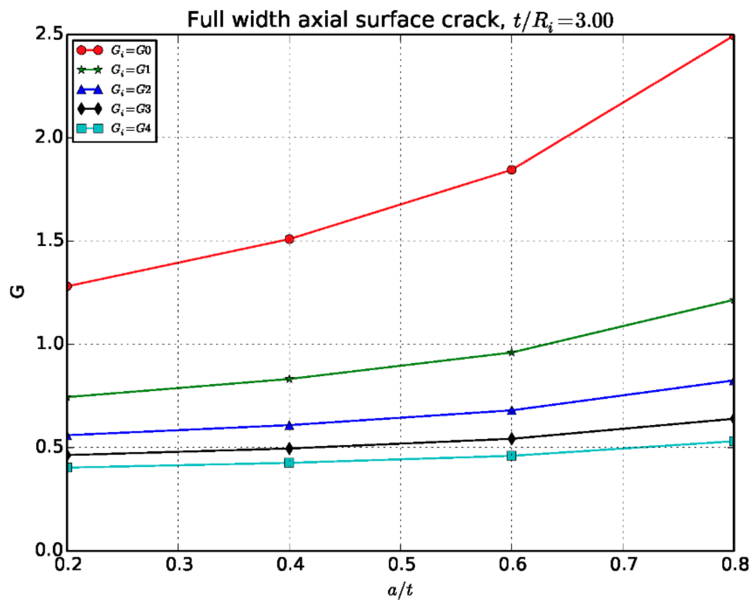
Plots shown for all the axial external full-width partial-depth crack cases; plot G versus the a/t ratio. G is constant along the full-width crack front, so just one G value per crack model. A curve for each of the five load cases: G0 to G4 for uniform, linear, quadratic, cubic, and quartic crack face pressure distributions. Five plots total for each t/Ri ratio.





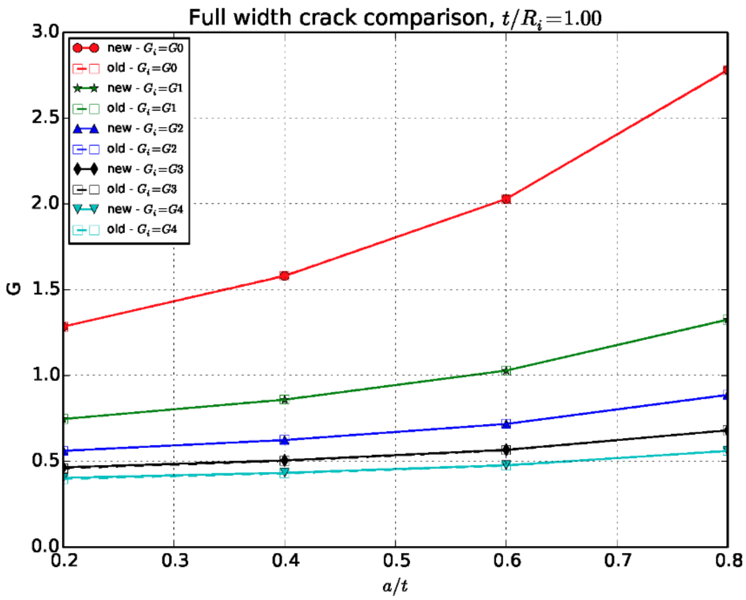

Full width axial surface crack, $t/R_i = 2.00$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Full width axial surface crack, $t/R_i = 2.50$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Full width axial surface crack, $t/R_i = 3.00$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8

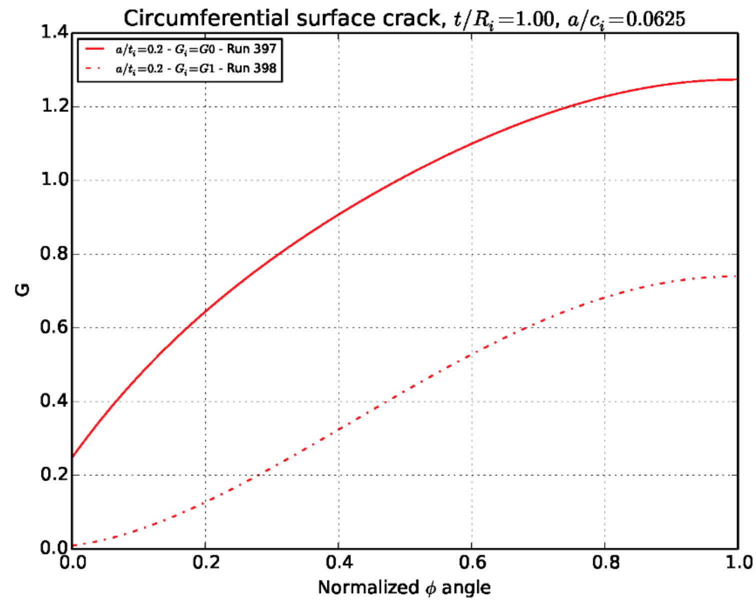
APPENDIX I: AXIAL EXTERNAL FULL-WIDTH CRACK COMPARISON TO PREVIOUS RESULTS

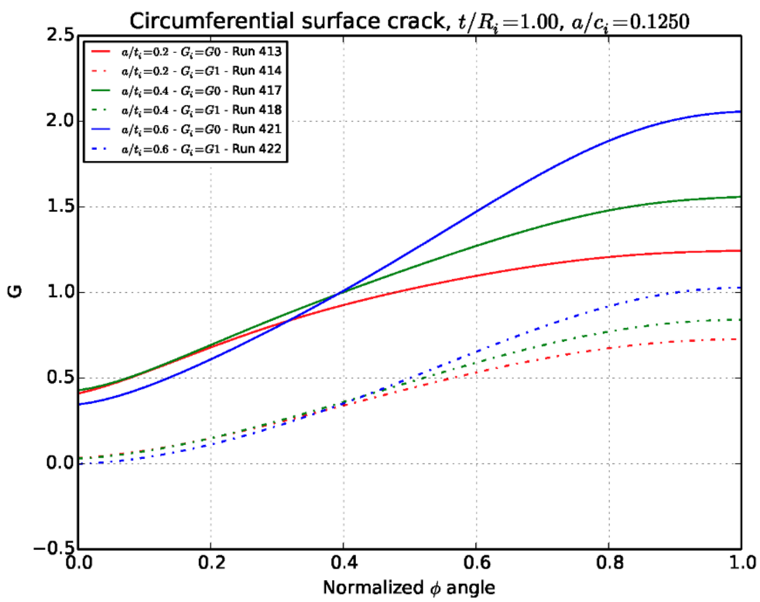
Plots to compare axial full-width crack G results for the t/Ri=1 ratio from the previous results to the new results. Plot G versus the a/t ratio for the five load cases; one plot. Close agreement between previous and new results. The previous results were obtained from API 579, Annex C, Table C.10 [1].

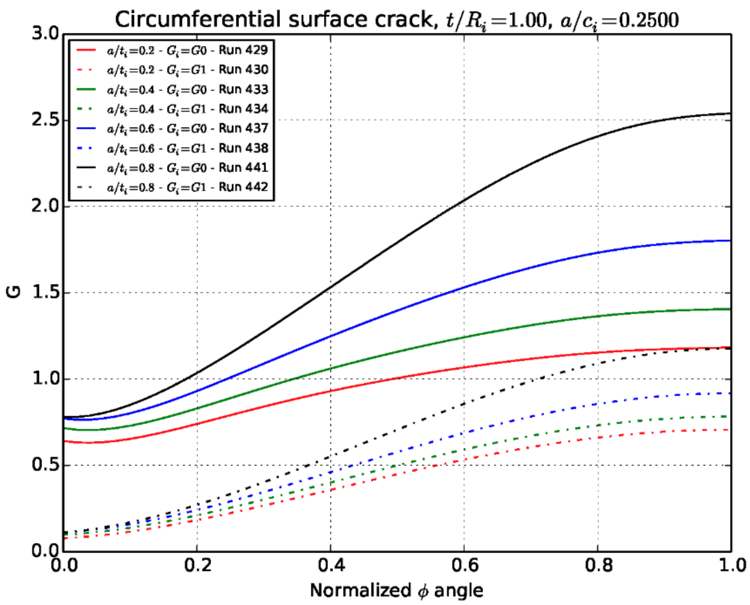


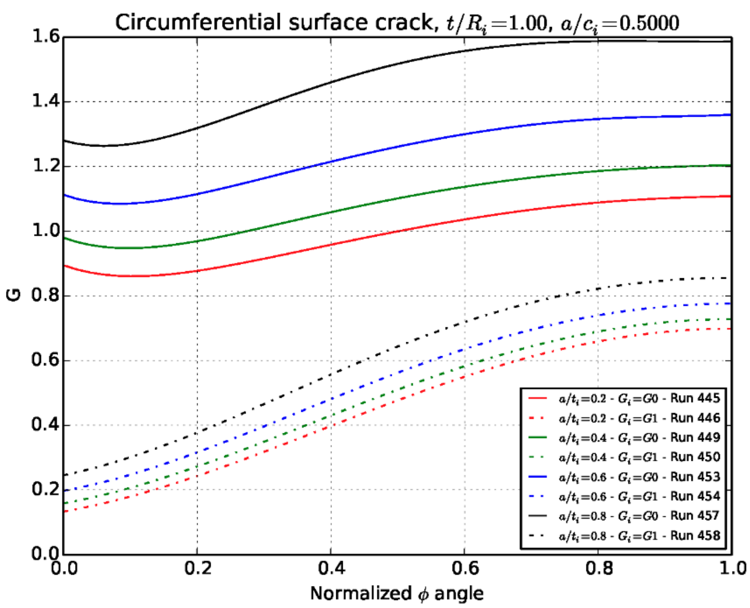
APPENDIX J: CIRCUMFERENTIAL EXTERNAL SURFACE CRACK G RESULTS PLOTS

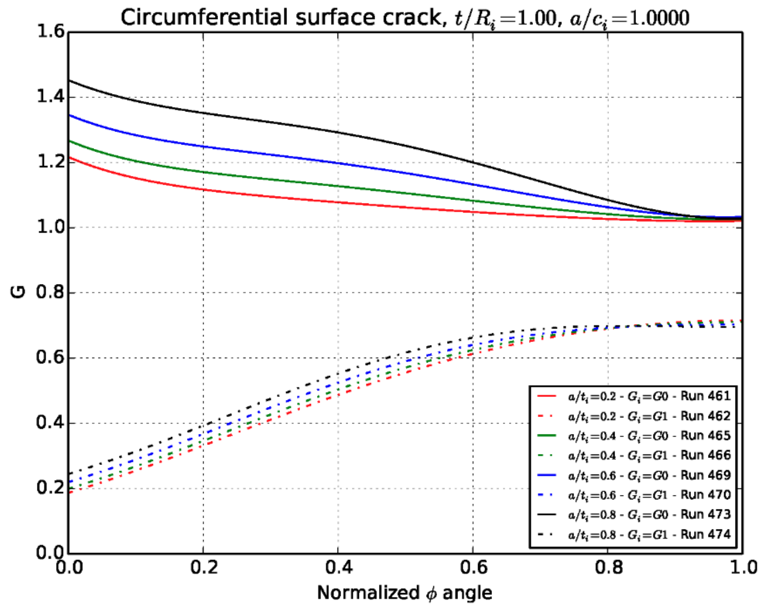
Plots shown for all the circumferential surface crack cases; plot G versus the normalized crack front angle position $2\phi/\pi$. Up to eight curves per plot to show the uniform G_0, linear G_1, in-plane bending G_5, and out-of-plane bending G_6 load cases for the four a/t ratios; 60 plots total. Each page contains the plots for a particular t/Ri and a/c ratio. The G_0 and G_1 results are in the first 30 plots, and the G_5 and G_6 results are in the last 30 plots.

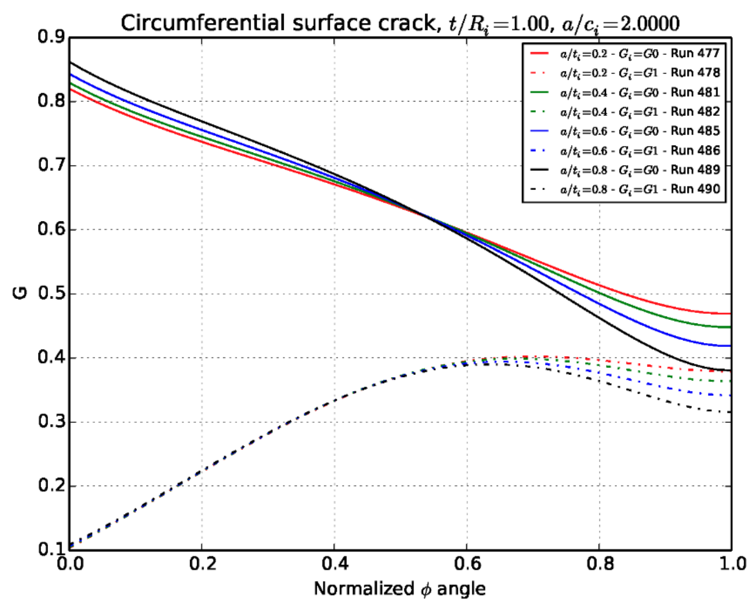


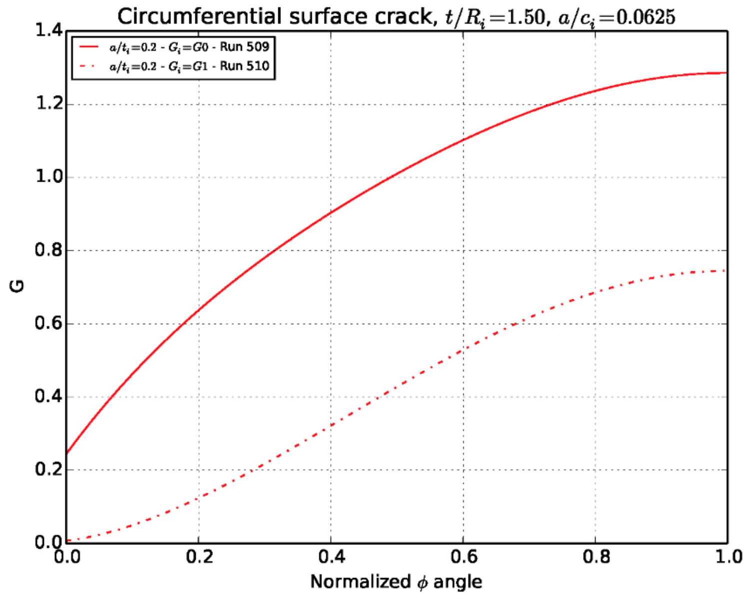


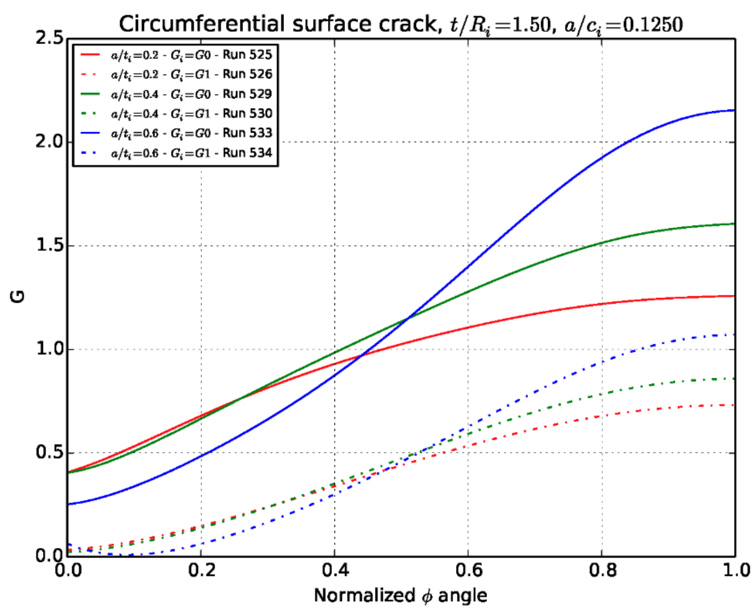

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 429
$a/t_i = 0.2$ - $G_i = G1$ - Run 430
$a/t_i = 0.4$ - $G_i = G0$ - Run 433
$a/t_i = 0.4$ - $G_i = G1$ - Run 434
$a/t_i = 0.6$ - $G_i = G0$ - Run 437
$a/t_i = 0.6$ - $G_i = G1$ - Run 438
$a/t_i = 0.8$ - $G_i = G0$ - Run 441
$a/t_i = 0.8$ - $G_i = G1$ - Run 442
G
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

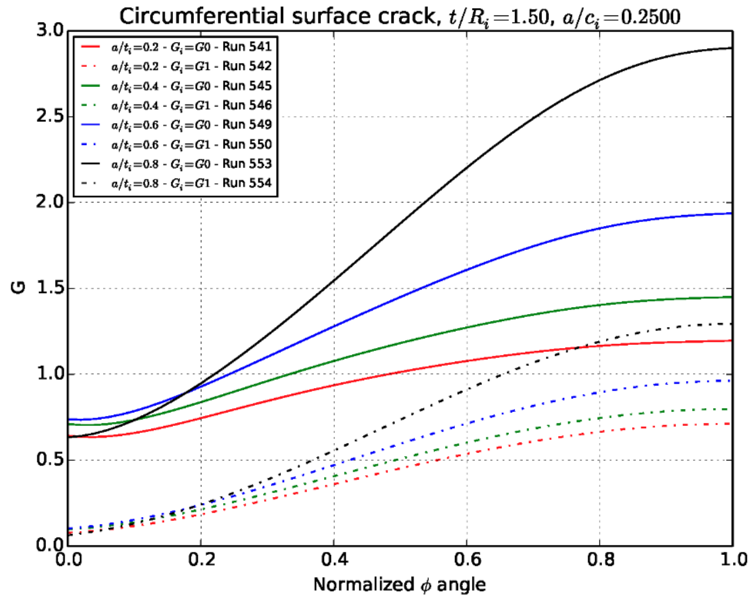

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 0.5000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 445
$a/t_i = 0.2$ - $G_i = G1$ - Run 446
$a/t_i = 0.4$ - $G_i = G0$ - Run 449
$a/t_i = 0.4$ - $G_i = G1$ - Run 450
$a/t_i = 0.6$ - $G_i = G0$ - Run 453
$a/t_i = 0.6$ - $G_i = G1$ - Run 454
$a/t_i = 0.8$ - $G_i = G0$ - Run 457
$a/t_i = 0.8$ - $G_i = G1$ - Run 458
G
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

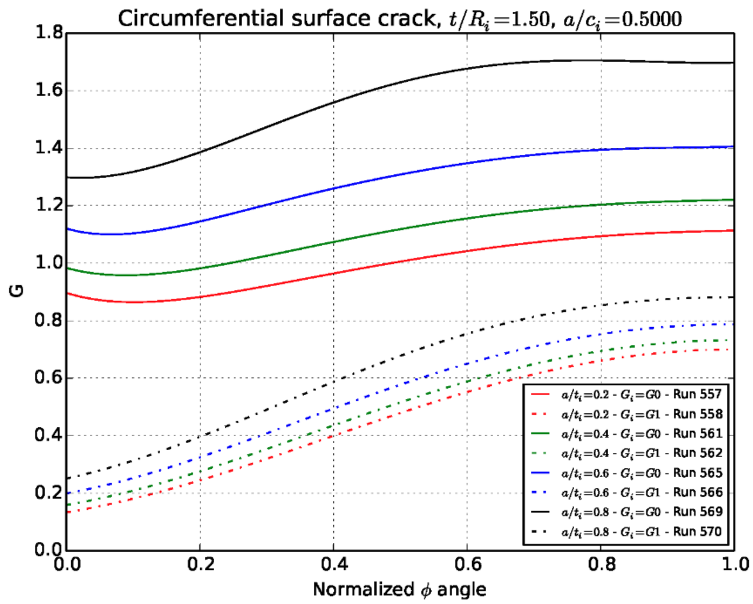

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 1.0000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 461
$a/t_i = 0.2$ - $G_i = G1$ - Run 462
$a/t_i = 0.4$ - $G_i = G0$ - Run 465
$a/t_i = 0.4$ - $G_i = G1$ - Run 466
$a/t_i = 0.6$ - $G_i = G0$ - Run 469
$a/t_i = 0.6$ - $G_i = G1$ - Run 470
$a/t_i = 0.8$ - $G_i = G0$ - Run 473
$a/t_i = 0.8$ - $G_i = G1$ - Run 474

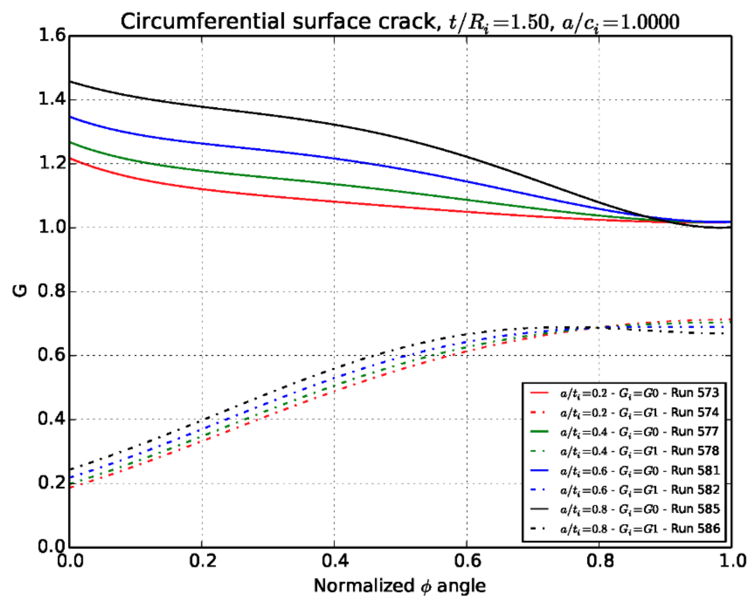

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 2.0000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 477
$a/t_i = 0.2$ - $G_i = G1$ - Run 478
$a/t_i = 0.4$ - $G_i = G0$ - Run 481
$a/t_i = 0.4$ - $G_i = G1$ - Run 482
$a/t_i = 0.6$ - $G_i = G0$ - Run 485
$a/t_i = 0.6$ - $G_i = G1$ - Run 486
$a/t_i = 0.8$ - $G_i = G0$ - Run 489
$a/t_i = 0.8$ - $G_i = G1$ - Run 490

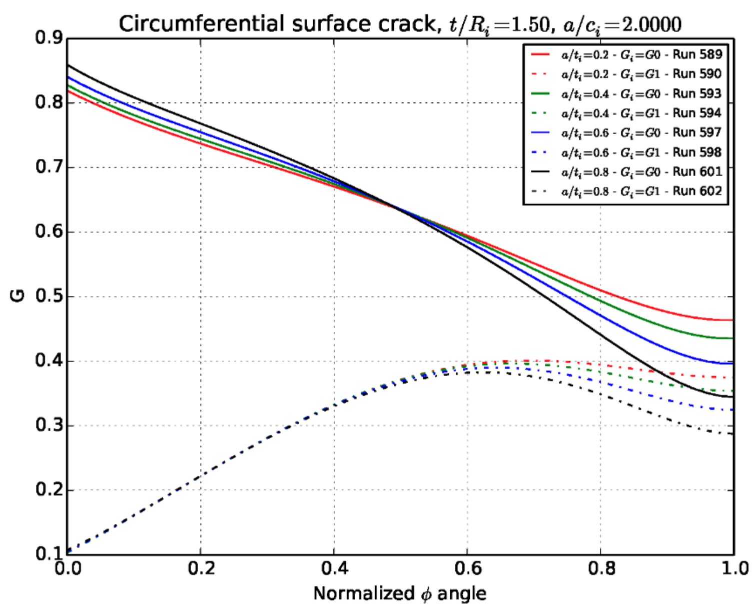

Circumferential surface crack, $t/R_i=1.50$, $a/c_i=0.0625$
$a/t_i=0.2$ - $G_i=G0$ - Run 509
$a/t_i=0.2$ - $G_i=G1$ - Run 510
G
Normalized ϕ angle
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

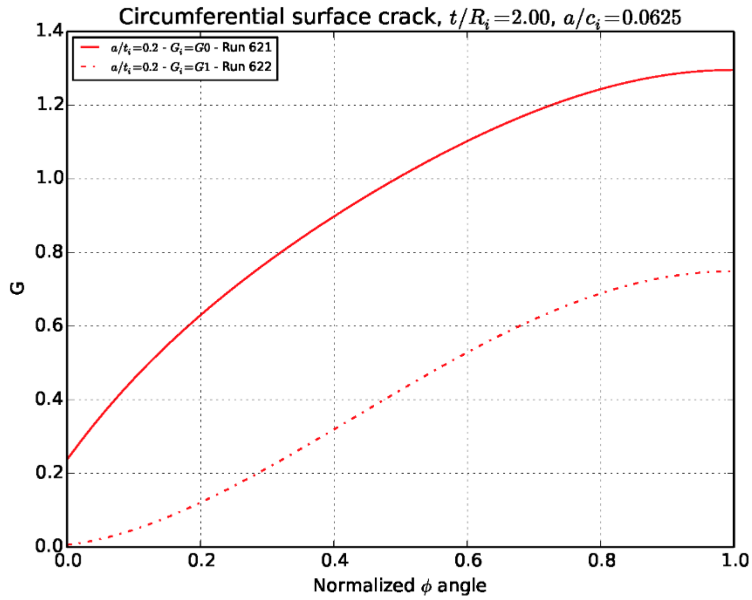

Circumferential surface crack, $t/R_i=1.50$, $a/c_i=0.1250$
$a/t_i=0.2$ - $G_i=G0$ - Run 525
$a/t_i=0.2$ - $G_i=G1$ - Run 526
$a/t_i=0.4$ - $G_i=G0$ - Run 529
$a/t_i=0.4$ - $G_i=G1$ - Run 530
$a/t_i=0.6$ - $G_i=G0$ - Run 533
$a/t_i=0.6$ - $G_i=G1$ - Run 534
G
Normalized ϕ angle
0.0
0.5
1.0
1.5
2.0
2.5
0.2
0.4
0.6
0.8


Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.2500$
a/t_i=0.2 - G_i=G0 - Run 541
a/t_i=0.2 - G_i=G1 - Run 542
a/t_i=0.4 - G_i=G0 - Run 545
a/t_i=0.4 - G_i=G1 - Run 546
a/t_i=0.6 - G_i=G0 - Run 549
a/t_i=0.6 - G_i=G1 - Run 550
a/t_i=0.8 - G_i=G0 - Run 553
a/t_i=0.8 - G_i=G1 - Run 554
G
Normalized ϕ angle

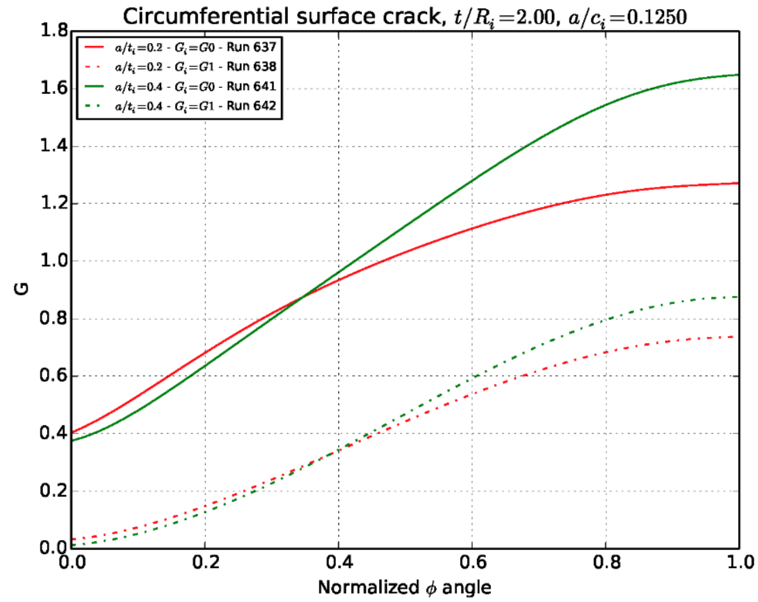

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.5000$
a/t_i=0.2 - G_i=G0 - Run 557
a/t_i=0.2 - G_i=G1 - Run 558
a/t_i=0.4 - G_i=G0 - Run 561
a/t_i=0.4 - G_i=G1 - Run 562
a/t_i=0.6 - G_i=G0 - Run 565
a/t_i=0.6 - G_i=G1 - Run 566
a/t_i=0.8 - G_i=G0 - Run 569
a/t_i=0.8 - G_i=G1 - Run 570
G
Normalized ϕ angle

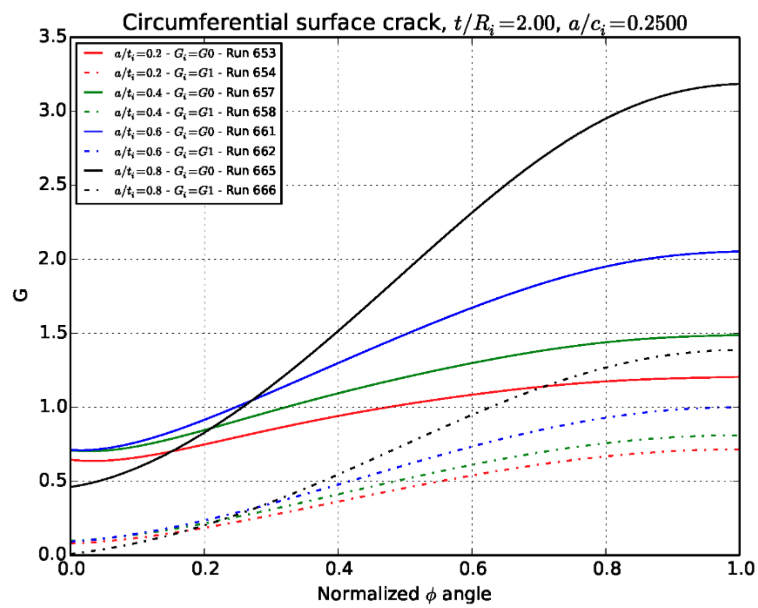

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 573
a/t_i=0.2 - G_i=G1 - Run 574
a/t_i=0.4 - G_i=G0 - Run 577
a/t_i=0.4 - G_i=G1 - Run 578
a/t_i=0.6 - G_i=G0 - Run 581
a/t_i=0.6 - G_i=G1 - Run 582
a/t_i=0.8 - G_i=G0 - Run 585
a/t_i=0.8 - G_i=G1 - Run 586

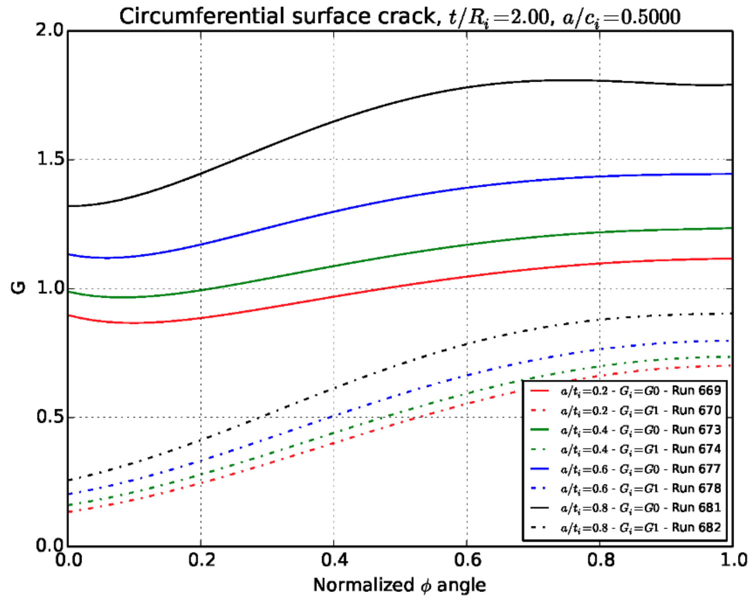

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 2.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 589
a/t_i=0.2 - G_i=G1 - Run 590
a/t_i=0.4 - G_i=G0 - Run 593
a/t_i=0.4 - G_i=G1 - Run 594
a/t_i=0.6 - G_i=G0 - Run 597
a/t_i=0.6 - G_i=G1 - Run 598
a/t_i=0.8 - G_i=G0 - Run 601
a/t_i=0.8 - G_i=G1 - Run 602

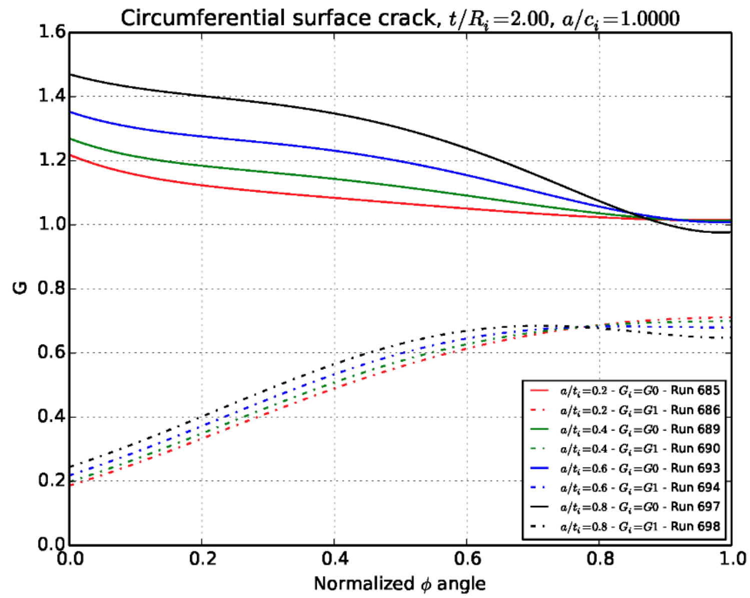


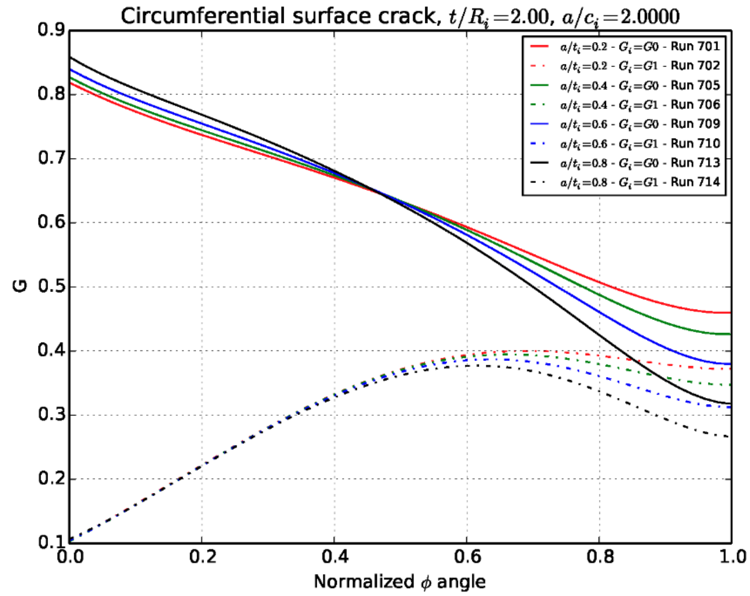
Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 621
$a/t_i = 0.2$ - $G_i = G1$ - Run 622
G
Normalized ϕ angle
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

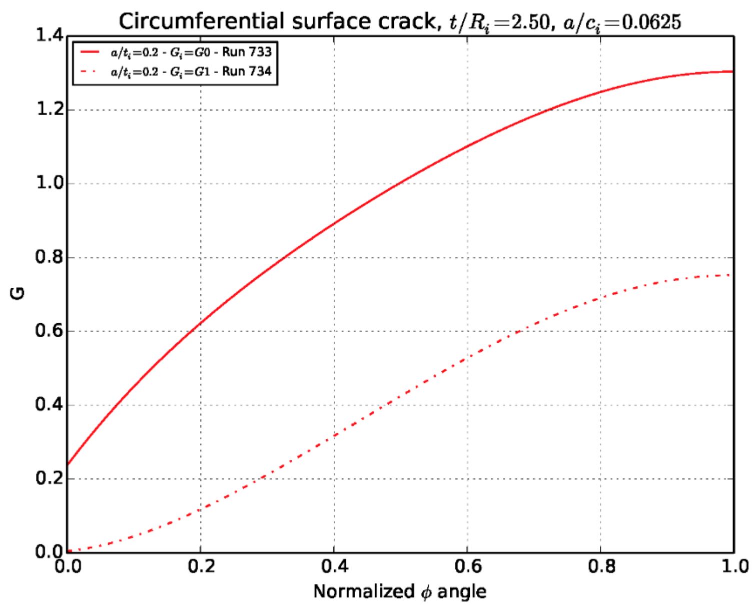

Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 637
$a/t_i = 0.2$ - $G_i = G1$ - Run 638
$a/t_i = 0.4$ - $G_i = G0$ - Run 641
$a/t_i = 0.4$ - $G_i = G1$ - Run 642
G
Normalized ϕ angle

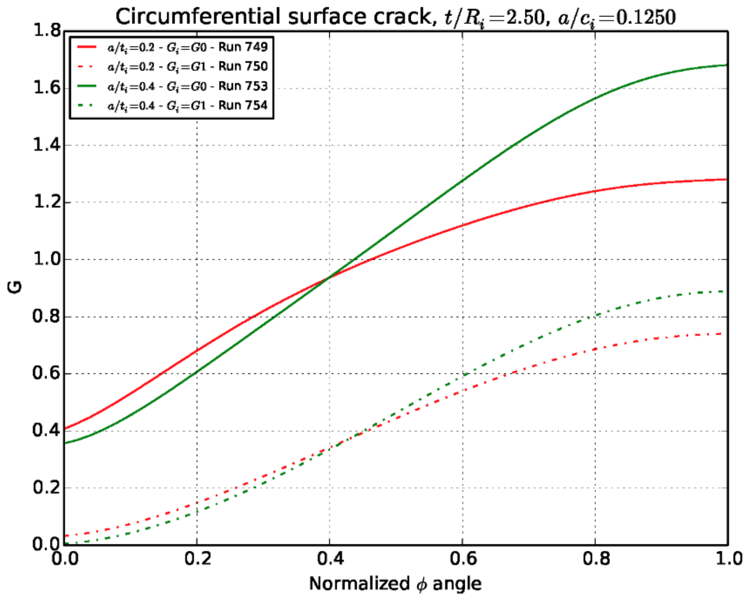

Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 653
$a/t_i = 0.2$ - $G_i = G1$ - Run 654
$a/t_i = 0.4$ - $G_i = G0$ - Run 657
$a/t_i = 0.4$ - $G_i = G1$ - Run 658
$a/t_i = 0.6$ - $G_i = G0$ - Run 661
$a/t_i = 0.6$ - $G_i = G1$ - Run 662
$a/t_i = 0.8$ - $G_i = G0$ - Run 665
$a/t_i = 0.8$ - $G_i = G1$ - Run 666
G
Normalized ϕ angle

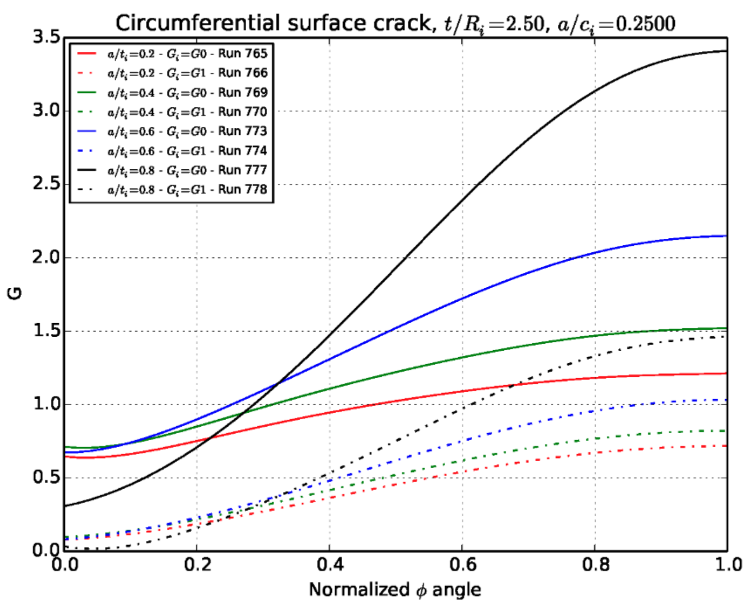

Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 0.5000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 669
$a/t_i = 0.2$ - $G_i = G1$ - Run 670
$a/t_i = 0.4$ - $G_i = G0$ - Run 673
$a/t_i = 0.4$ - $G_i = G1$ - Run 674
$a/t_i = 0.6$ - $G_i = G0$ - Run 677
$a/t_i = 0.6$ - $G_i = G1$ - Run 678
$a/t_i = 0.8$ - $G_i = G0$ - Run 681
$a/t_i = 0.8$ - $G_i = G1$ - Run 682

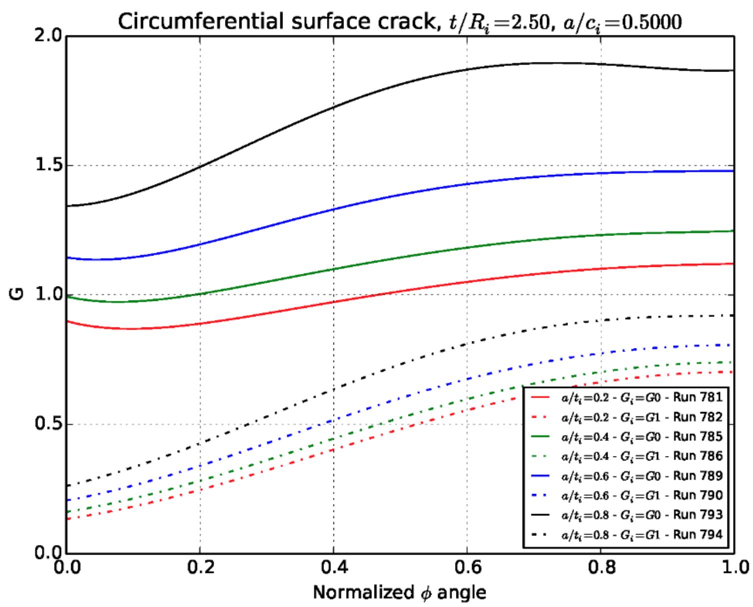

Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 1.0000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G0$ - Run 685
$a/t_i = 0.2$ - $G_i = G1$ - Run 686
$a/t_i = 0.4$ - $G_i = G0$ - Run 689
$a/t_i = 0.4$ - $G_i = G1$ - Run 690
$a/t_i = 0.6$ - $G_i = G0$ - Run 693
$a/t_i = 0.6$ - $G_i = G1$ - Run 694
$a/t_i = 0.8$ - $G_i = G0$ - Run 697
$a/t_i = 0.8$ - $G_i = G1$ - Run 698

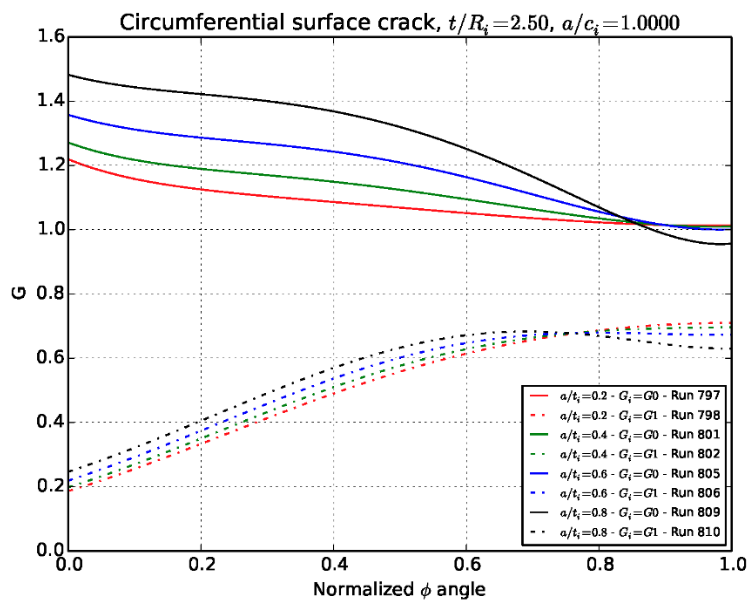

Circumferential surface crack, $t/R_i=2.00$, $a/c_i=2.0000$
a/t_i=0.2 - G_i=G0 - Run 701
a/t_i=0.2 - G_i=G1 - Run 702
a/t_i=0.4 - G_i=G0 - Run 705
a/t_i=0.4 - G_i=G1 - Run 706
a/t_i=0.6 - G_i=G0 - Run 709
a/t_i=0.6 - G_i=G1 - Run 710
a/t_i=0.8 - G_i=G0 - Run 713
a/t_i=0.8 - G_i=G1 - Run 714
G
Normalized ϕ angle

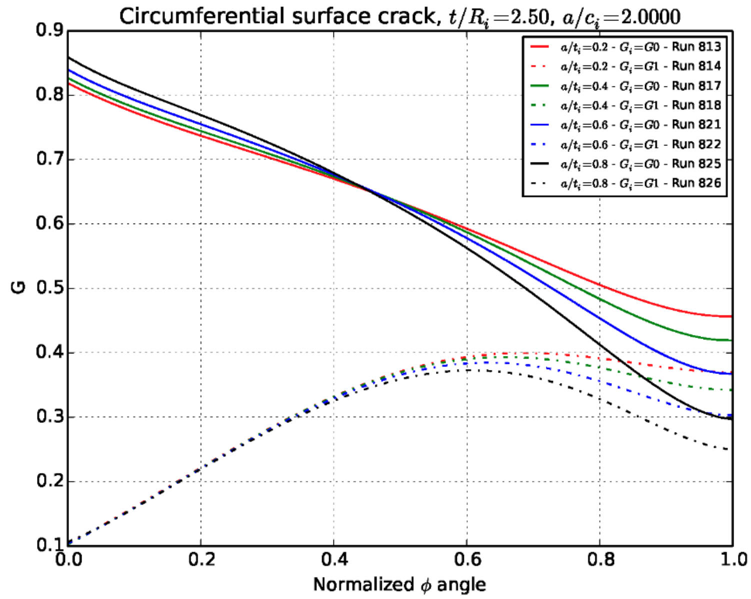

Circumferential surface crack, $t/R_i=2.50$, $a/c_i=0.0625$
a/t_i=0.2 - G_i=G0 - Run 733
a/t_i=0.2 - G_i=G1 - Run 734
G
Normalized ϕ angle

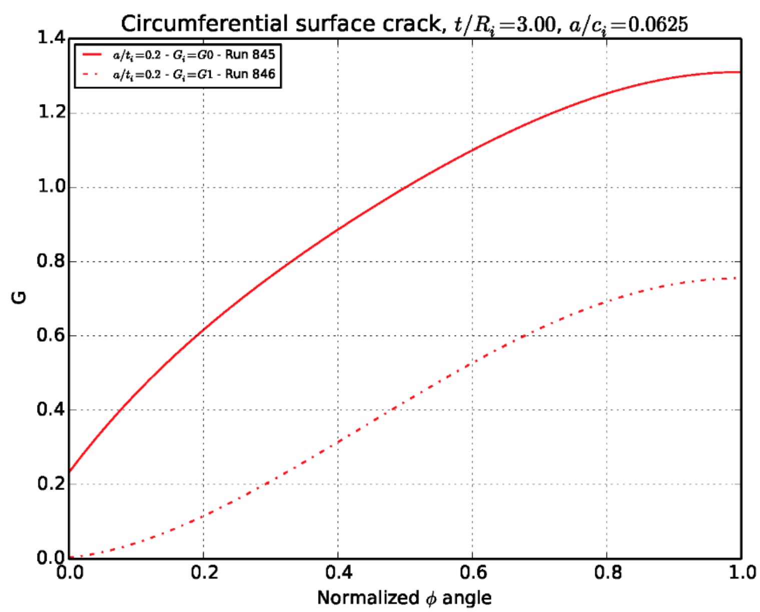

Circumferential surface crack, $t/R_i = 2.50$, $a/c_i = 0.1250$
a/t_i=0.2 - G_i=G0 - Run 749
a/t_i=0.2 - G_i=G1 - Run 750
a/t_i=0.4 - G_i=G0 - Run 753
a/t_i=0.4 - G_i=G1 - Run 754
G
Normalized ϕ angle

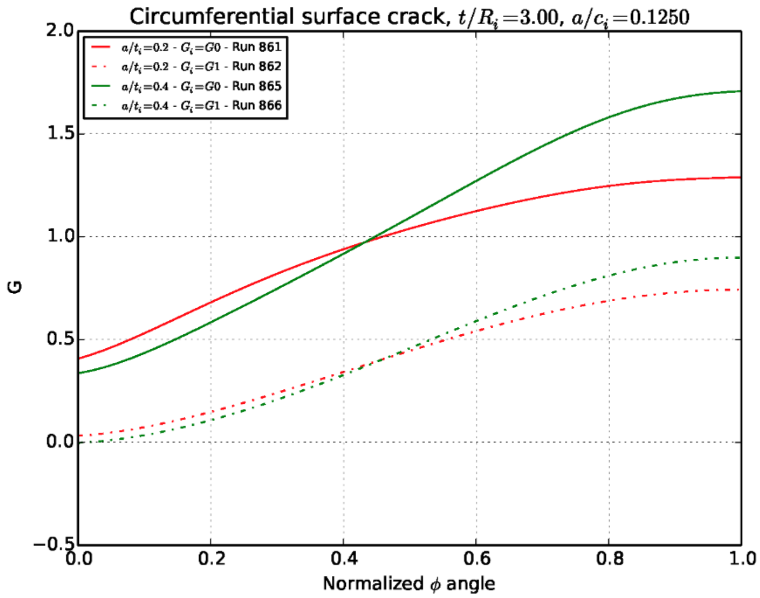

Circumferential surface crack, $t/R_i = 2.50$, $a/c_i = 0.2500$
a/t_i=0.2 - G_i=G0 - Run 765
a/t_i=0.2 - G_i=G1 - Run 766
a/t_i=0.4 - G_i=G0 - Run 769
a/t_i=0.4 - G_i=G1 - Run 770
a/t_i=0.6 - G_i=G0 - Run 773
a/t_i=0.6 - G_i=G1 - Run 774
a/t_i=0.8 - G_i=G0 - Run 777
a/t_i=0.8 - G_i=G1 - Run 778
G
Normalized ϕ angle

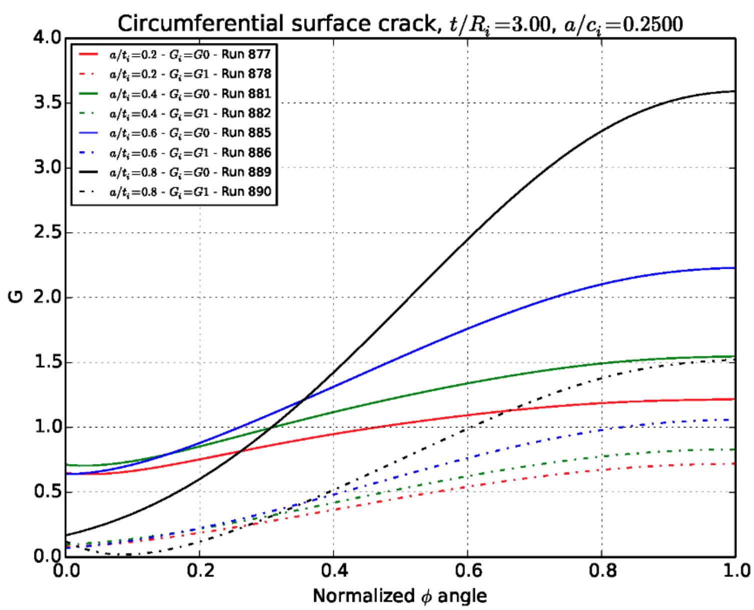

Circumferential surface crack, $t/R_i=2.50$, $a/c_i=0.5000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 781
a/t_i=0.2 - G_i=G1 - Run 782
a/t_i=0.4 - G_i=G0 - Run 785
a/t_i=0.4 - G_i=G1 - Run 786
a/t_i=0.6 - G_i=G0 - Run 789
a/t_i=0.6 - G_i=G1 - Run 790
a/t_i=0.8 - G_i=G0 - Run 793
a/t_i=0.8 - G_i=G1 - Run 794

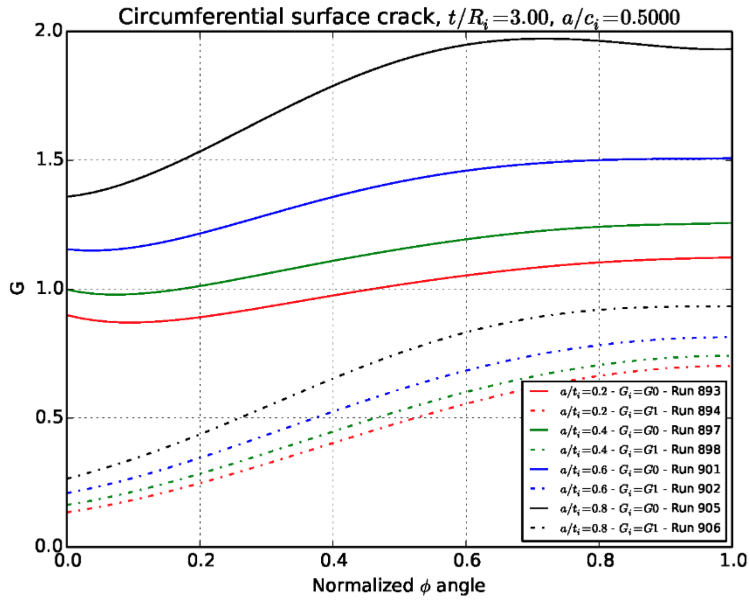

Circumferential surface crack, $t/R_i=2.50$, $a/c_i=1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G0 - Run 797
a/t_i=0.2 - G_i=G1 - Run 798
a/t_i=0.4 - G_i=G0 - Run 801
a/t_i=0.4 - G_i=G1 - Run 802
a/t_i=0.6 - G_i=G0 - Run 805
a/t_i=0.6 - G_i=G1 - Run 806
a/t_i=0.8 - G_i=G0 - Run 809
a/t_i=0.8 - G_i=G1 - Run 810

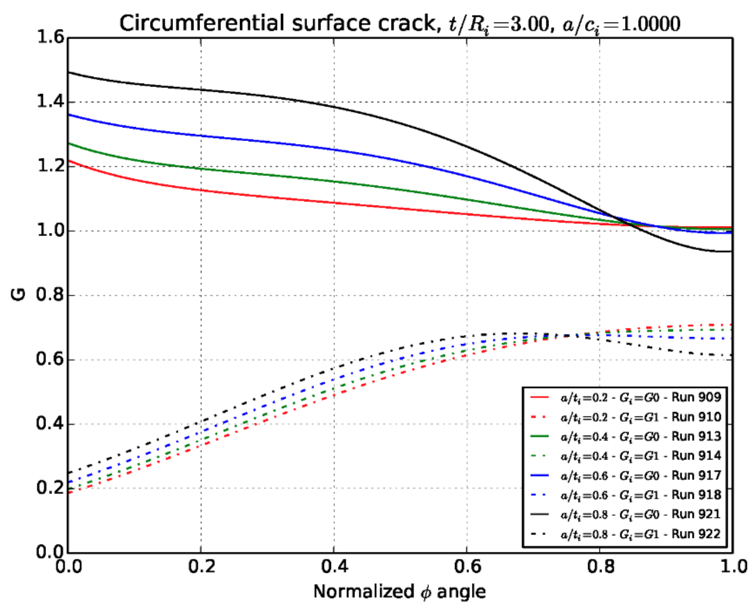

Circumferential surface crack, $t/R_i = 2.50$, $a/c_i = 2.0000$
$a/t_i = 0.2$ - $G_i = G0$ - Run 813
$a/t_i = 0.2$ - $G_i = G1$ - Run 814
$a/t_i = 0.4$ - $G_i = G0$ - Run 817
$a/t_i = 0.4$ - $G_i = G1$ - Run 818
$a/t_i = 0.6$ - $G_i = G0$ - Run 821
$a/t_i = 0.6$ - $G_i = G1$ - Run 822
$a/t_i = 0.8$ - $G_i = G0$ - Run 825
$a/t_i = 0.8$ - $G_i = G1$ - Run 826
G
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

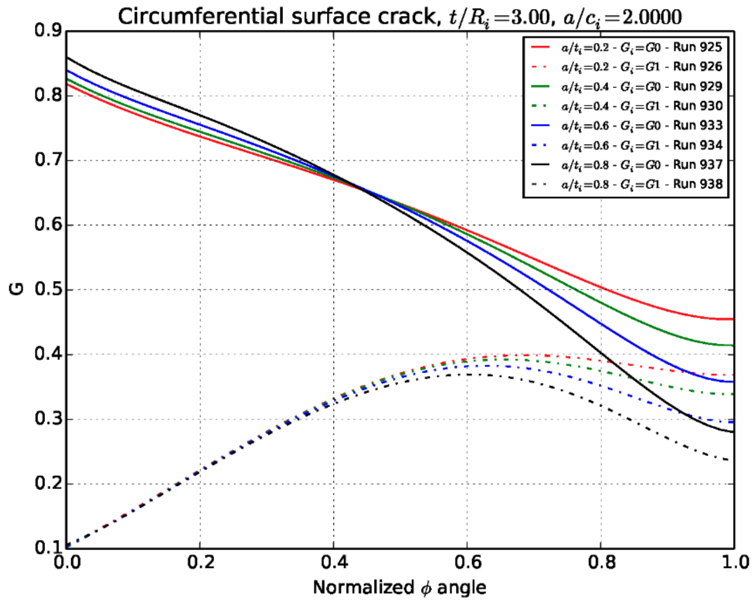

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G0$ - Run 845
$a/t_i = 0.2$ - $G_i = G1$ - Run 846
G
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

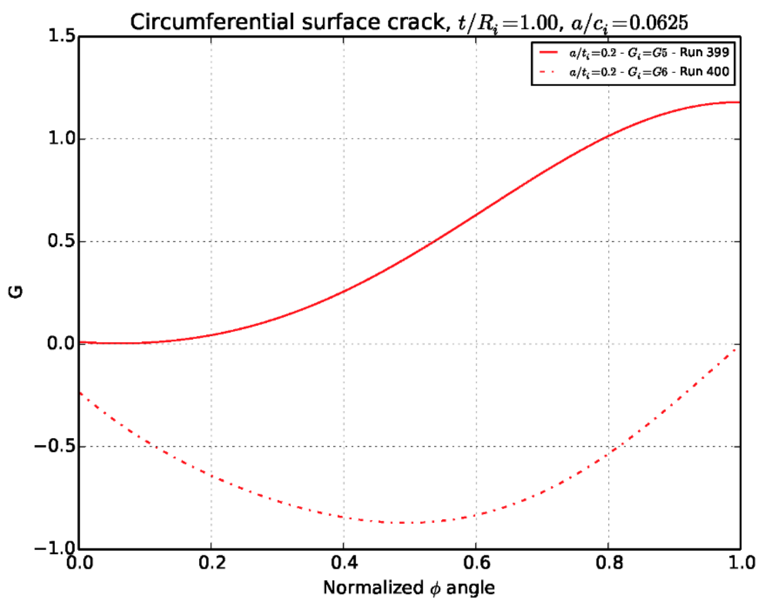

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G0$ - Run 861
$a/t_i = 0.2$ - $G_i = G1$ - Run 862
$a/t_i = 0.4$ - $G_i = G0$ - Run 865
$a/t_i = 0.4$ - $G_i = G1$ - Run 866
G
2.0
1.5
1.0
0.5
0.0
−0.5
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

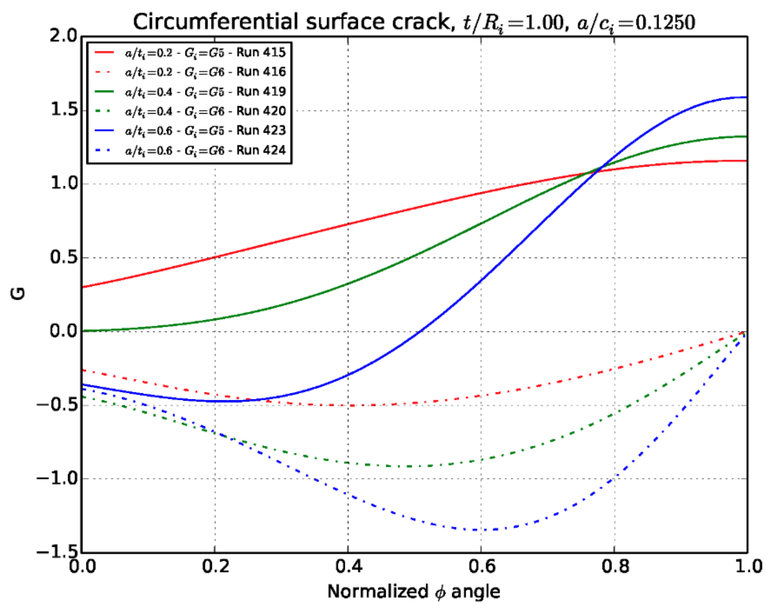

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G0$ - Run 877
$a/t_i = 0.2$ - $G_i = G1$ - Run 878
$a/t_i = 0.4$ - $G_i = G0$ - Run 881
$a/t_i = 0.4$ - $G_i = G1$ - Run 882
$a/t_i = 0.6$ - $G_i = G0$ - Run 885
$a/t_i = 0.6$ - $G_i = G1$ - Run 886
$a/t_i = 0.8$ - $G_i = G0$ - Run 889
$a/t_i = 0.8$ - $G_i = G1$ - Run 890
G
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

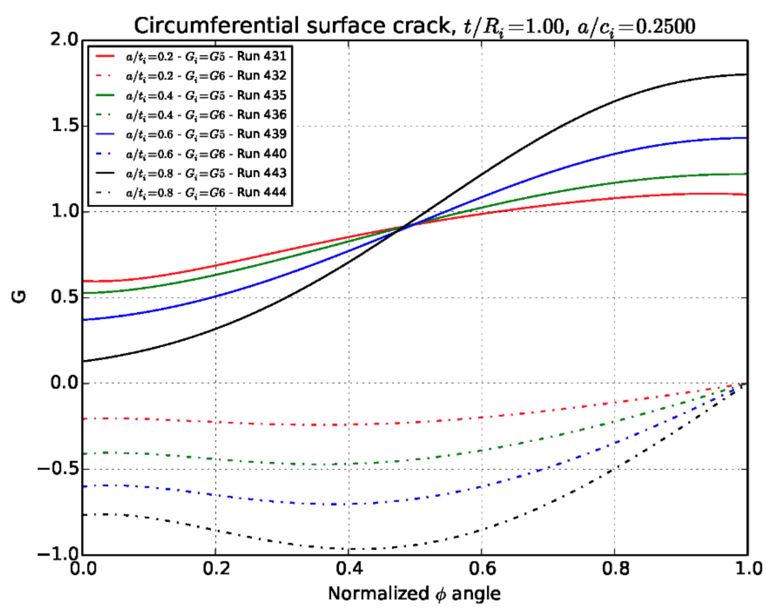

Circumferential surface crack, $t/R_i=3.00$, $a/c_i=0.5000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G0$ - Run 893
$a/t_i=0.2$ - $G_i=G1$ - Run 894
$a/t_i=0.4$ - $G_i=G0$ - Run 897
$a/t_i=0.4$ - $G_i=G1$ - Run 898
$a/t_i=0.6$ - $G_i=G0$ - Run 901
$a/t_i=0.6$ - $G_i=G1$ - Run 902
$a/t_i=0.8$ - $G_i=G0$ - Run 905
$a/t_i=0.8$ - $G_i=G1$ - Run 906

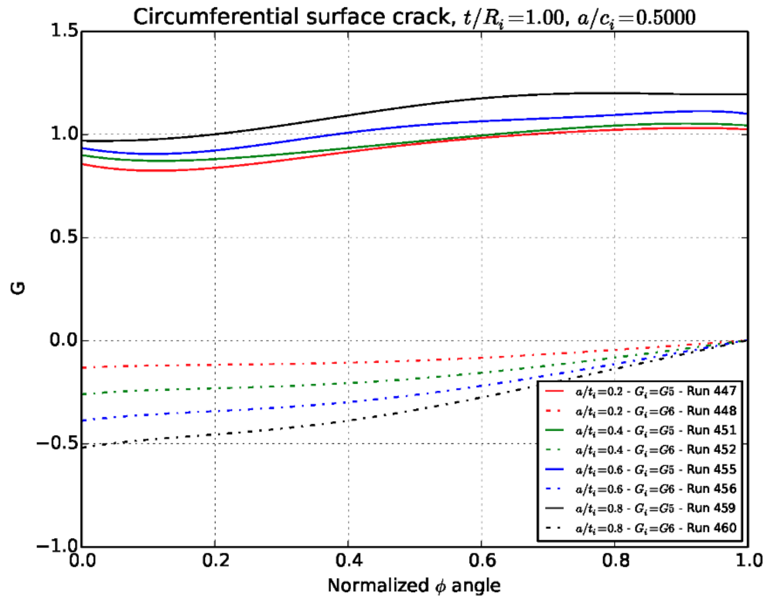

Circumferential surface crack, $t/R_i=3.00$, $a/c_i=1.0000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G0$ - Run 909
$a/t_i=0.2$ - $G_i=G1$ - Run 910
$a/t_i=0.4$ - $G_i=G0$ - Run 913
$a/t_i=0.4$ - $G_i=G1$ - Run 914
$a/t_i=0.6$ - $G_i=G0$ - Run 917
$a/t_i=0.6$ - $G_i=G1$ - Run 918
$a/t_i=0.8$ - $G_i=G0$ - Run 921
$a/t_i=0.8$ - $G_i=G1$ - Run 922

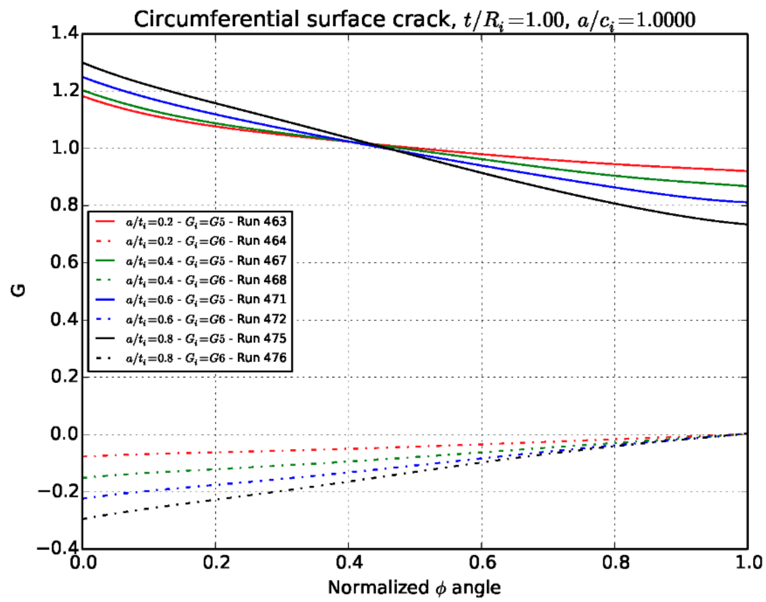

Circumferential surface crack, $t/R_i=3.00$, $a/c_i=2.0000$
$a/t_i=0.2$ - $G_i=G0$ - Run 925
$a/t_i=0.2$ - $G_i=G1$ - Run 926
$a/t_i=0.4$ - $G_i=G0$ - Run 929
$a/t_i=0.4$ - $G_i=G1$ - Run 930
$a/t_i=0.6$ - $G_i=G0$ - Run 933
$a/t_i=0.6$ - $G_i=G1$ - Run 934
$a/t_i=0.8$ - $G_i=G0$ - Run 937
$a/t_i=0.8$ - $G_i=G1$ - Run 938
G
Normalized ϕ angle

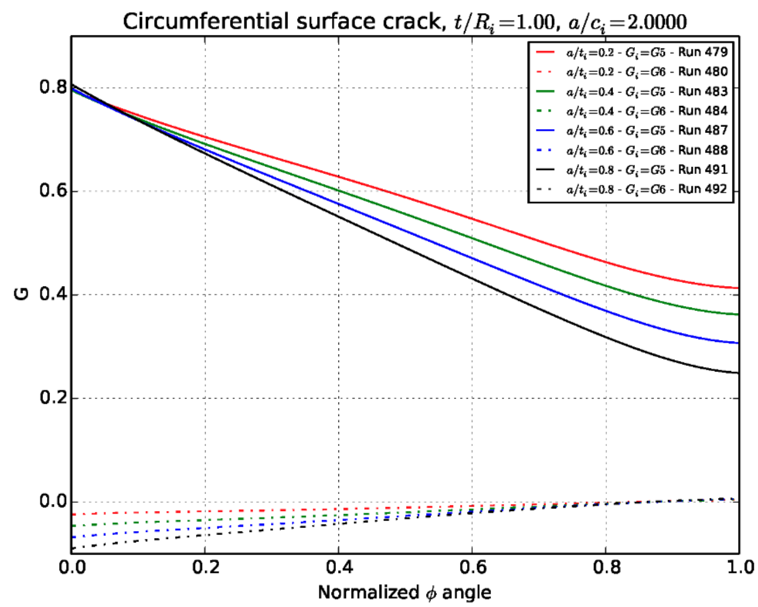

Circumferential surface crack, $t/R_i=1.00$, $a/c_i=0.0625$
$a/t_i=0.2$ - $G_i=G5$ - Run 399
$a/t_i=0.2$ - $G_i=G6$ - Run 400
G
Normalized ϕ angle

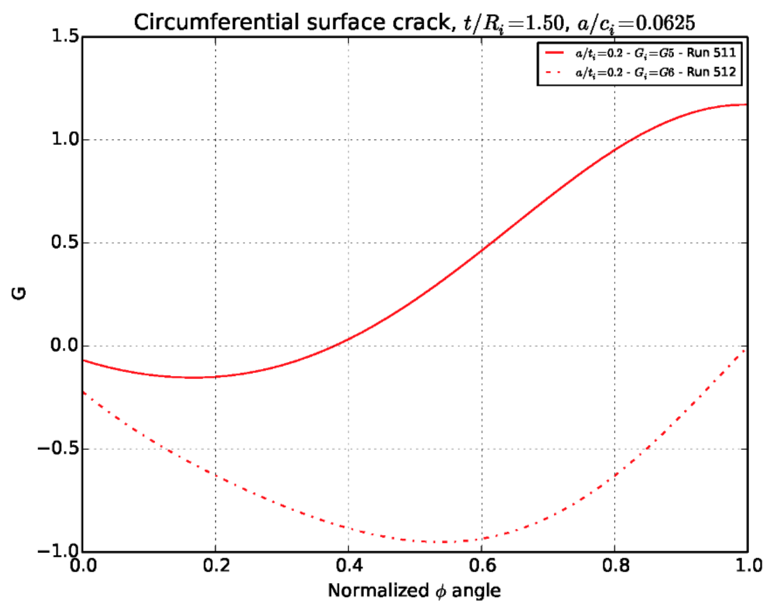

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 0.1250$
$a/t_i = 0.2$ - $G_i = G5$ - Run 415
$a/t_i = 0.2$ - $G_i = G6$ - Run 416
$a/t_i = 0.4$ - $G_i = G5$ - Run 419
$a/t_i = 0.4$ - $G_i = G6$ - Run 420
$a/t_i = 0.6$ - $G_i = G5$ - Run 423
$a/t_i = 0.6$ - $G_i = G6$ - Run 424
G
Normalized ϕ angle

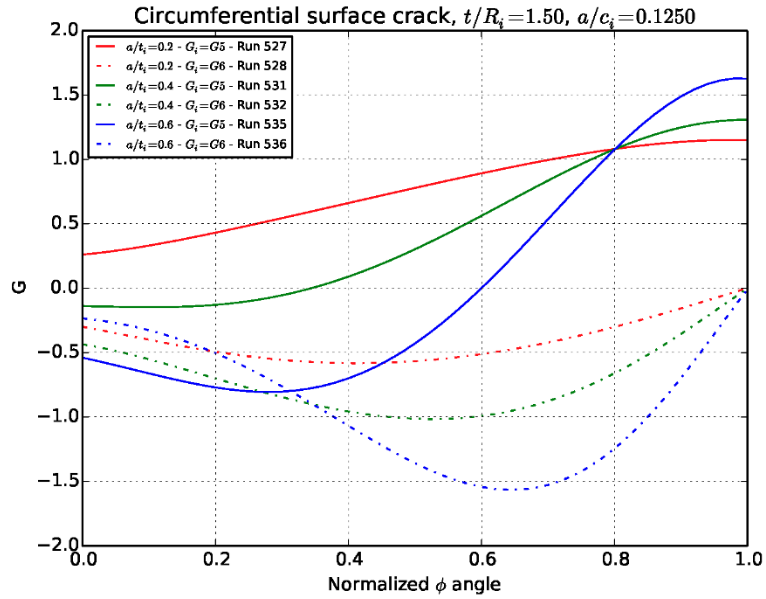

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 0.2500$
$a/t_i = 0.2$ - $G_i = G5$ - Run 431
$a/t_i = 0.2$ - $G_i = G6$ - Run 432
$a/t_i = 0.4$ - $G_i = G5$ - Run 435
$a/t_i = 0.4$ - $G_i = G6$ - Run 436
$a/t_i = 0.6$ - $G_i = G5$ - Run 439
$a/t_i = 0.6$ - $G_i = G6$ - Run 440
$a/t_i = 0.8$ - $G_i = G5$ - Run 443
$a/t_i = 0.8$ - $G_i = G6$ - Run 444
G
Normalized ϕ angle

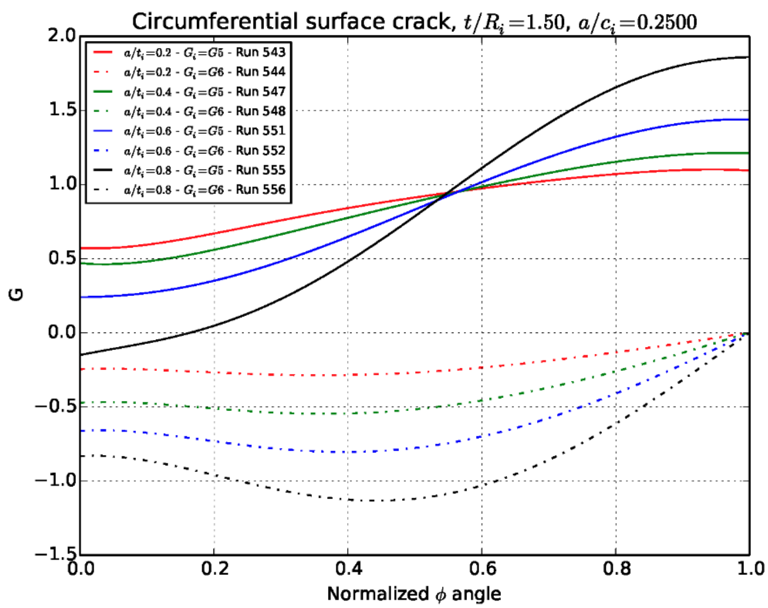

Circumferential surface crack, $t/R_i=1.00$, $a/c_i=0.5000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G5$ - Run 447
$a/t_i=0.2$ - $G_i=G6$ - Run 448
$a/t_i=0.4$ - $G_i=G5$ - Run 451
$a/t_i=0.4$ - $G_i=G6$ - Run 452
$a/t_i=0.6$ - $G_i=G5$ - Run 455
$a/t_i=0.6$ - $G_i=G6$ - Run 456
$a/t_i=0.8$ - $G_i=G5$ - Run 459
$a/t_i=0.8$ - $G_i=G6$ - Run 460

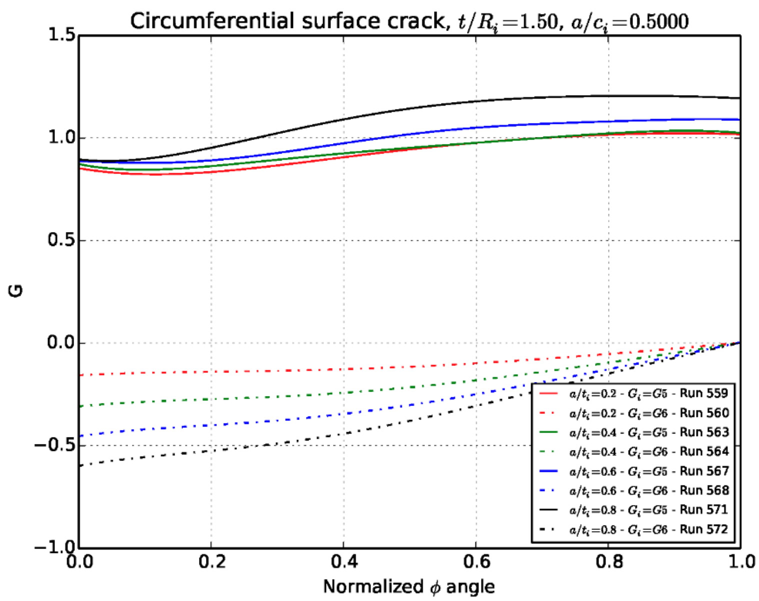

Circumferential surface crack, $t/R_i=1.00$, $a/c_i=1.0000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G5$ - Run 463
$a/t_i=0.2$ - $G_i=G6$ - Run 464
$a/t_i=0.4$ - $G_i=G5$ - Run 467
$a/t_i=0.4$ - $G_i=G6$ - Run 468
$a/t_i=0.6$ - $G_i=G5$ - Run 471
$a/t_i=0.6$ - $G_i=G6$ - Run 472
$a/t_i=0.8$ - $G_i=G5$ - Run 475
$a/t_i=0.8$ - $G_i=G6$ - Run 476

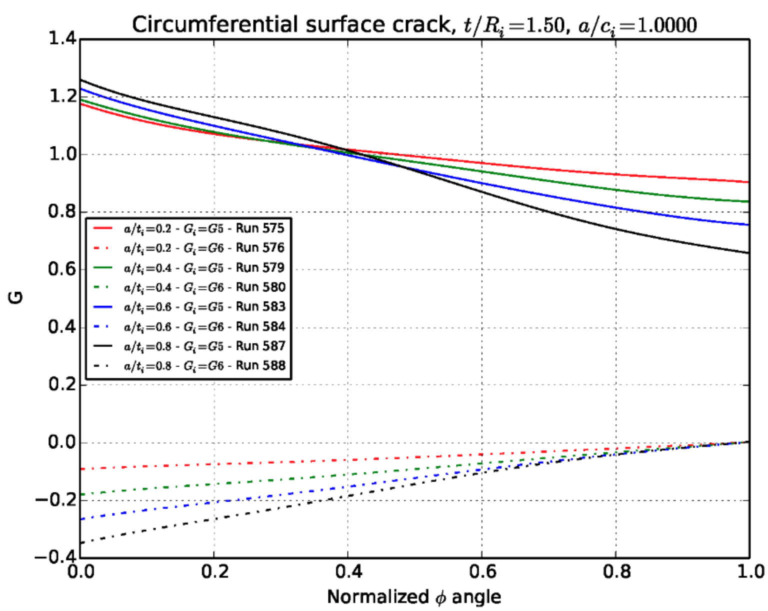

Circumferential surface crack, $t/R_i = 1.00$, $a/c_i = 2.0000$
$a/t_i = 0.2$ - $G_i = G5$ - Run 479
$a/t_i = 0.2$ - $G_i = G6$ - Run 480
$a/t_i = 0.4$ - $G_i = G5$ - Run 483
$a/t_i = 0.4$ - $G_i = G6$ - Run 484
$a/t_i = 0.6$ - $G_i = G5$ - Run 487
$a/t_i = 0.6$ - $G_i = G6$ - Run 488
$a/t_i = 0.8$ - $G_i = G5$ - Run 491
$a/t_i = 0.8$ - $G_i = G6$ - Run 492
G
Normalized ϕ angle

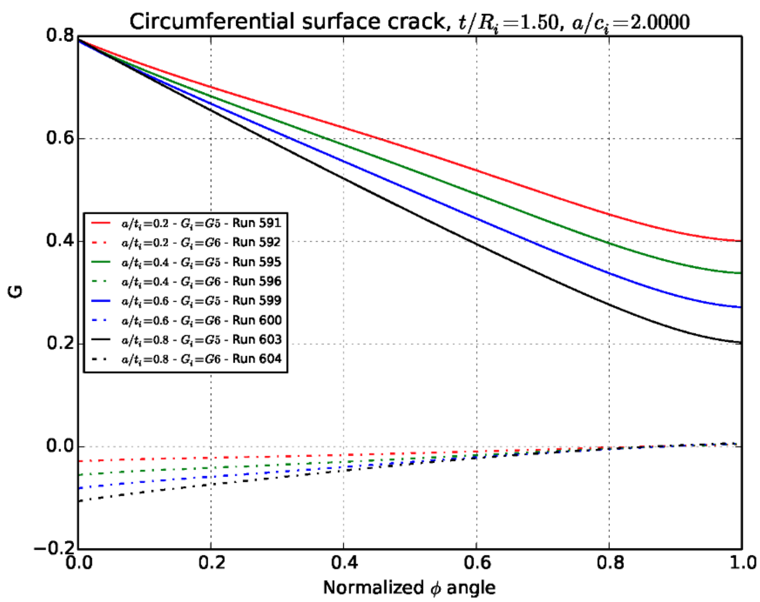

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.0625$
$a/t_i = 0.2$ - $G_i = G5$ - Run 511
$a/t_i = 0.2$ - $G_i = G6$ - Run 512
G
Normalized ϕ angle

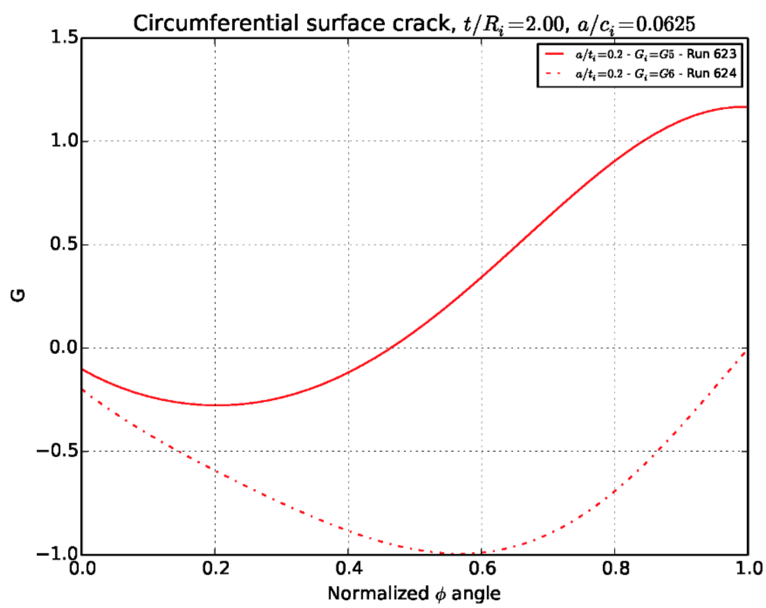

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.1250$
a/t_i=0.2 - G_i=G5 - Run 527
a/t_i=0.2 - G_i=G6 - Run 528
a/t_i=0.4 - G_i=G5 - Run 531
a/t_i=0.4 - G_i=G6 - Run 532
a/t_i=0.6 - G_i=G5 - Run 535
a/t_i=0.6 - G_i=G6 - Run 536
G
Normalized ϕ angle

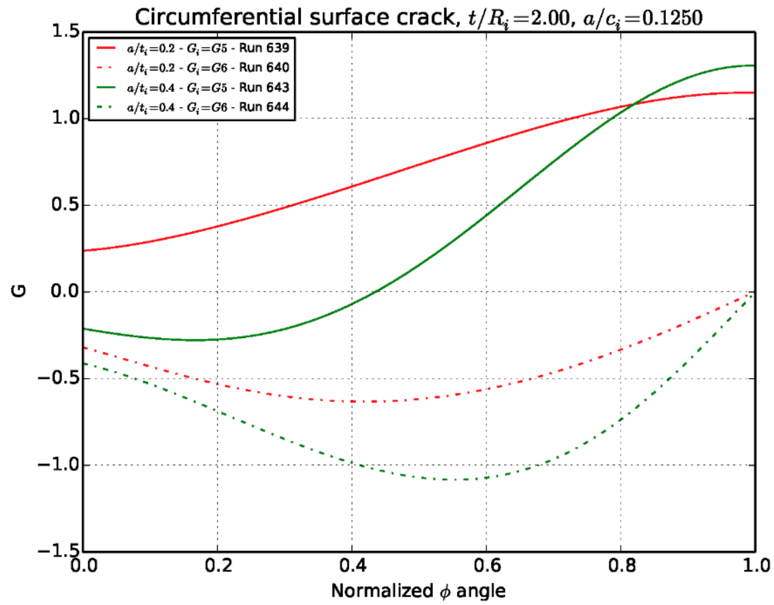

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.2500$
a/t_i=0.2 - G_i=G5 - Run 543
a/t_i=0.2 - G_i=G6 - Run 544
a/t_i=0.4 - G_i=G5 - Run 547
a/t_i=0.4 - G_i=G6 - Run 548
a/t_i=0.6 - G_i=G5 - Run 551
a/t_i=0.6 - G_i=G6 - Run 552
a/t_i=0.8 - G_i=G5 - Run 555
a/t_i=0.8 - G_i=G6 - Run 556
G
Normalized ϕ angle

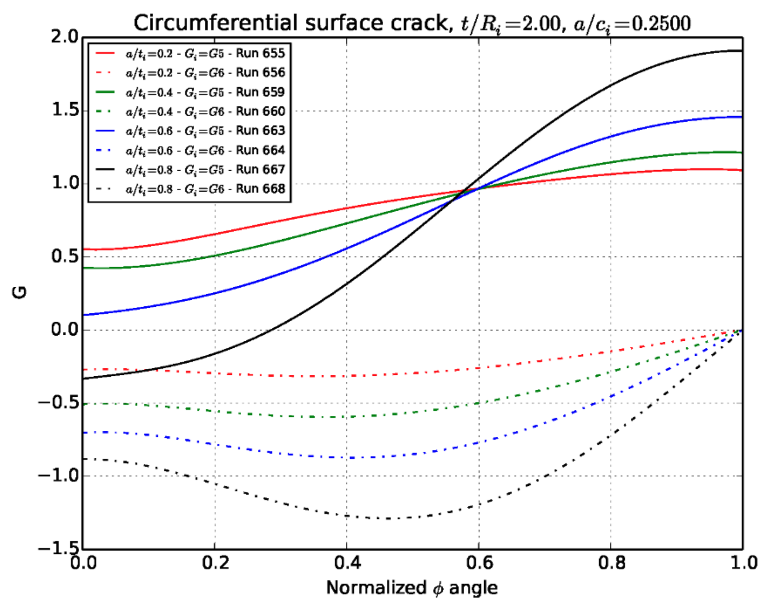

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 0.5000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 559
a/t_i=0.2 - G_i=G6 - Run 560
a/t_i=0.4 - G_i=G5 - Run 563
a/t_i=0.4 - G_i=G6 - Run 564
a/t_i=0.6 - G_i=G5 - Run 567
a/t_i=0.6 - G_i=G6 - Run 568
a/t_i=0.8 - G_i=G5 - Run 571
a/t_i=0.8 - G_i=G6 - Run 572

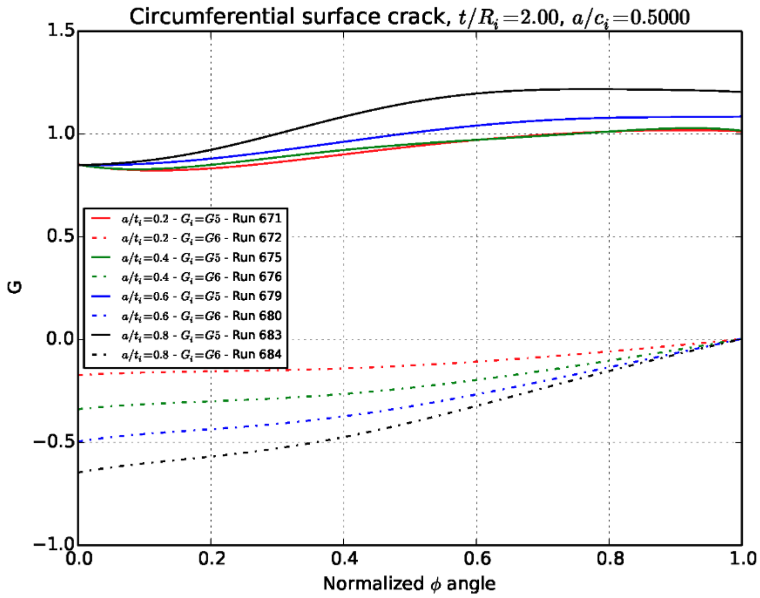

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 575
a/t_i=0.2 - G_i=G6 - Run 576
a/t_i=0.4 - G_i=G5 - Run 579
a/t_i=0.4 - G_i=G6 - Run 580
a/t_i=0.6 - G_i=G5 - Run 583
a/t_i=0.6 - G_i=G6 - Run 584
a/t_i=0.8 - G_i=G5 - Run 587
a/t_i=0.8 - G_i=G6 - Run 588

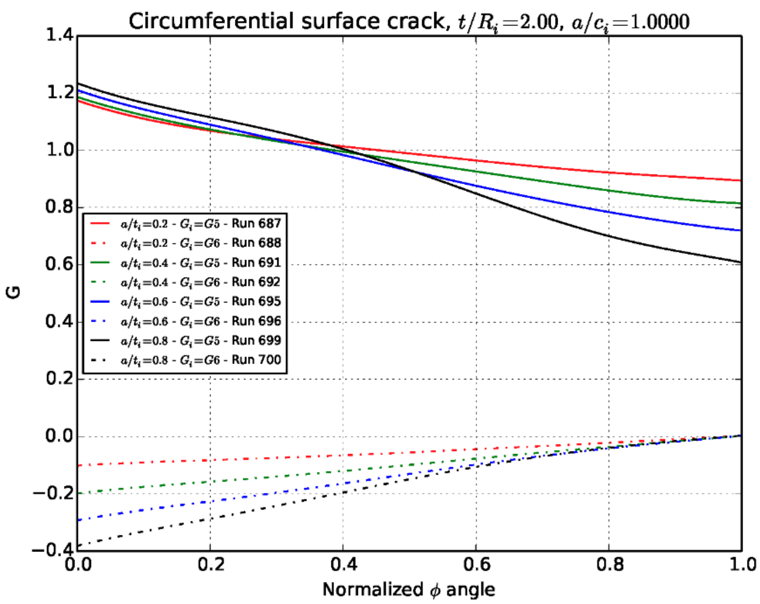

Circumferential surface crack, $t/R_i = 1.50$, $a/c_i = 2.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 591
a/t_i=0.2 - G_i=G6 - Run 592
a/t_i=0.4 - G_i=G5 - Run 595
a/t_i=0.4 - G_i=G6 - Run 596
a/t_i=0.6 - G_i=G5 - Run 599
a/t_i=0.6 - G_i=G6 - Run 600
a/t_i=0.8 - G_i=G5 - Run 603
a/t_i=0.8 - G_i=G6 - Run 604
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

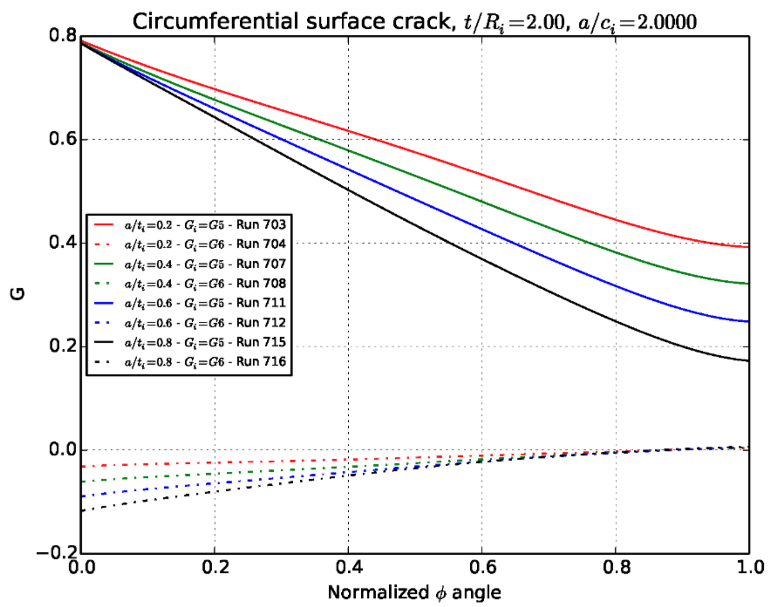

Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 0.0625$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 623
a/t_i=0.2 - G_i=G6 - Run 624
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
0.2
0.4
0.6
0.8
1.0

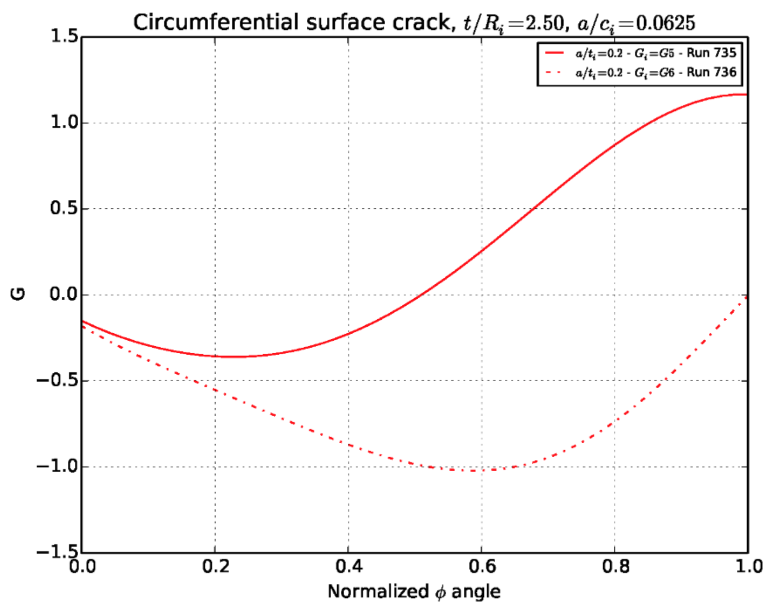

Circumferential surface crack, $t/R_i=2.00$, $a/c_i=0.1250$
$a/t_i=0.2$ - $G_i=G5$ - Run 639
$a/t_i=0.2$ - $G_i=G6$ - Run 640
$a/t_i=0.4$ - $G_i=G5$ - Run 643
$a/t_i=0.4$ - $G_i=G6$ - Run 644
G
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

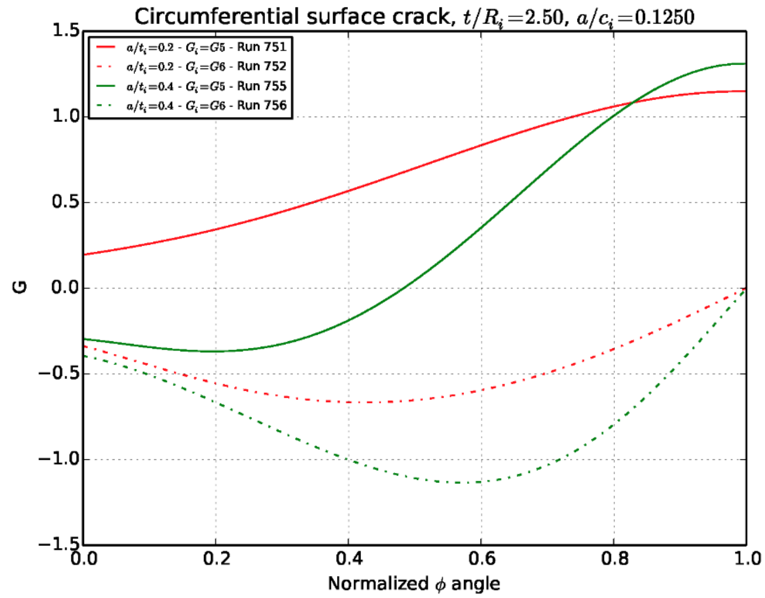

Circumferential surface crack, $t/R_i=2.00$, $a/c_i=0.2500$
$a/t_i=0.2$ - $G_i=G5$ - Run 655
$a/t_i=0.2$ - $G_i=G6$ - Run 656
$a/t_i=0.4$ - $G_i=G5$ - Run 659
$a/t_i=0.4$ - $G_i=G6$ - Run 660
$a/t_i=0.6$ - $G_i=G5$ - Run 663
$a/t_i=0.6$ - $G_i=G6$ - Run 664
$a/t_i=0.8$ - $G_i=G5$ - Run 667
$a/t_i=0.8$ - $G_i=G6$ - Run 668
G
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle


Circumferential surface crack, $t/R_i=2.00$, $a/c_i=0.5000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 671
a/t_i=0.2 - G_i=G6 - Run 672
a/t_i=0.4 - G_i=G5 - Run 675
a/t_i=0.4 - G_i=G6 - Run 676
a/t_i=0.6 - G_i=G5 - Run 679
a/t_i=0.6 - G_i=G6 - Run 680
a/t_i=0.8 - G_i=G5 - Run 683
a/t_i=0.8 - G_i=G6 - Run 684

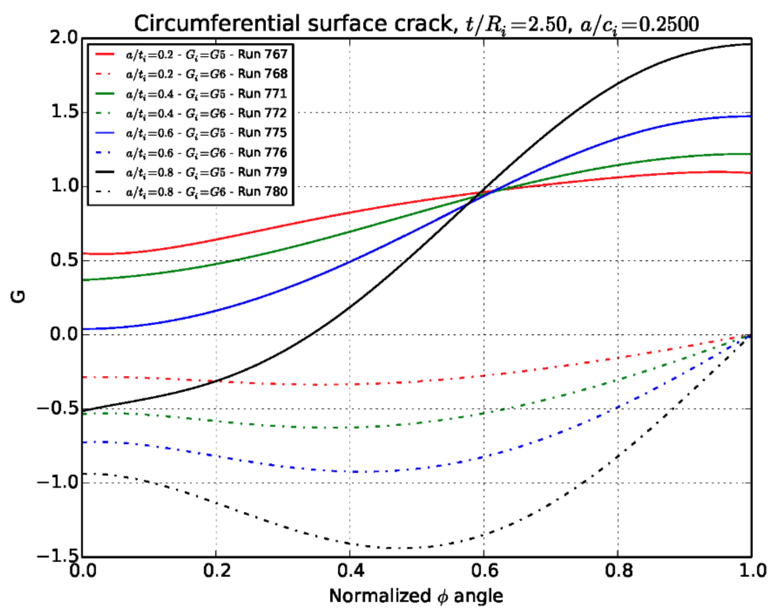

Circumferential surface crack, $t/R_i=2.00$, $a/c_i=1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=G5 - Run 687
a/t_i=0.2 - G_i=G6 - Run 688
a/t_i=0.4 - G_i=G5 - Run 691
a/t_i=0.4 - G_i=G6 - Run 692
a/t_i=0.6 - G_i=G5 - Run 695
a/t_i=0.6 - G_i=G6 - Run 696
a/t_i=0.8 - G_i=G5 - Run 699
a/t_i=0.8 - G_i=G6 - Run 700


Circumferential surface crack, $t/R_i = 2.00$, $a/c_i = 2.0000$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G5$ - Run 703
$a/t_i = 0.2$ - $G_i = G6$ - Run 704
$a/t_i = 0.4$ - $G_i = G5$ - Run 707
$a/t_i = 0.4$ - $G_i = G6$ - Run 708
$a/t_i = 0.6$ - $G_i = G5$ - Run 711
$a/t_i = 0.6$ - $G_i = G6$ - Run 712
$a/t_i = 0.8$ - $G_i = G5$ - Run 715
$a/t_i = 0.8$ - $G_i = G6$ - Run 716
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

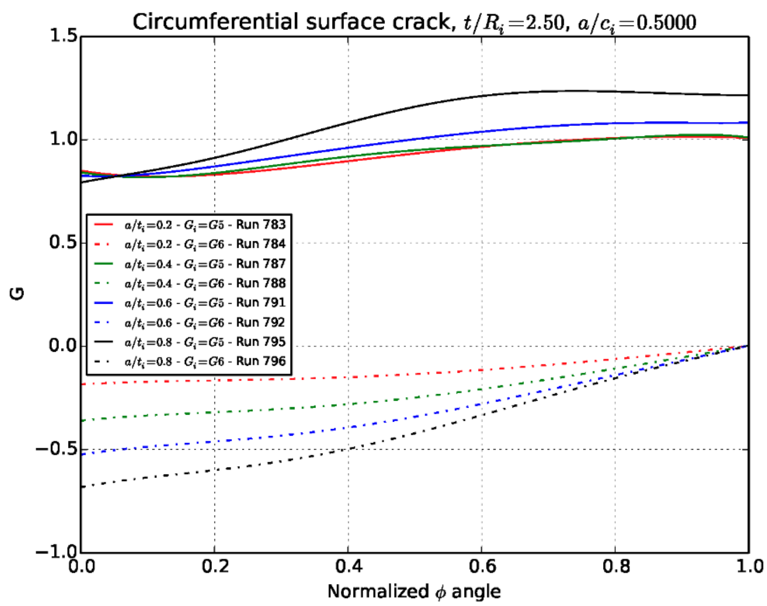

Circumferential surface crack, $t/R_i = 2.50$, $a/c_i = 0.0625$
G
Normalized ϕ angle
$a/t_i = 0.2$ - $G_i = G5$ - Run 735
$a/t_i = 0.2$ - $G_i = G6$ - Run 736
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0.0
0.2
0.4
0.6
0.8
1.0

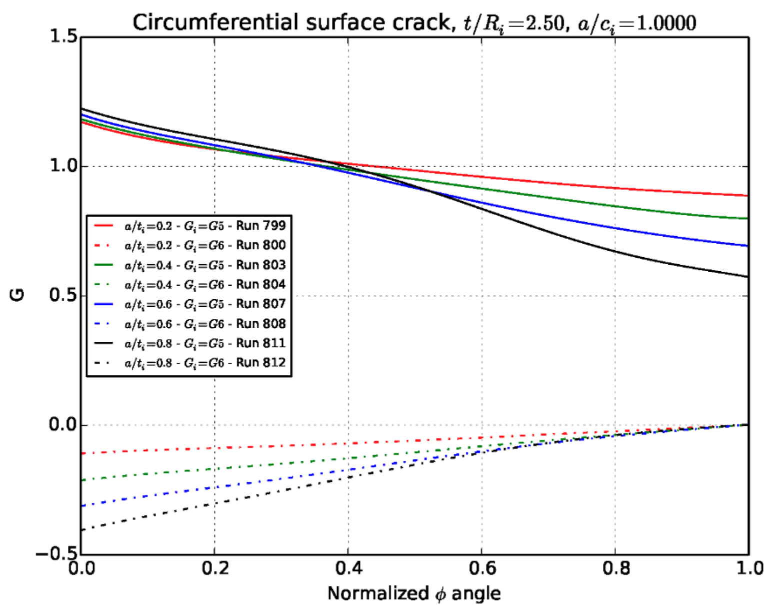


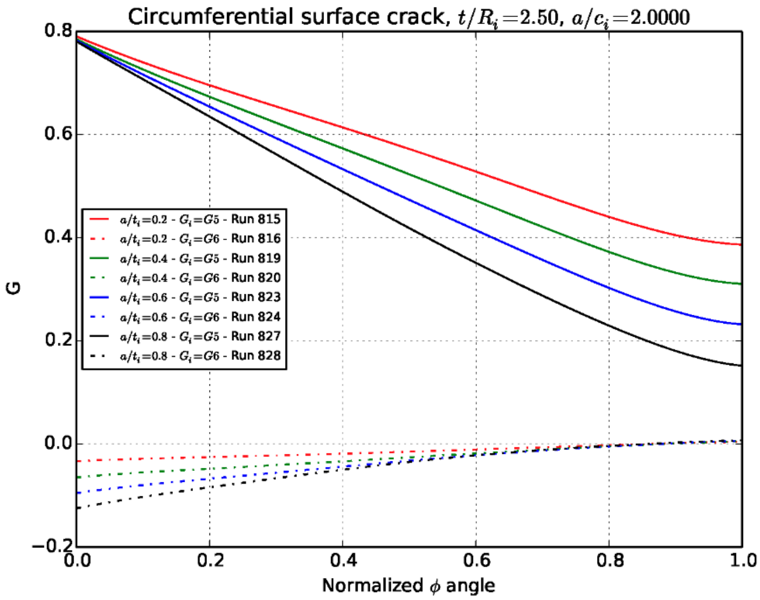
Circumferential surface crack, $t/R_i=2.50$, $a/c_i=0.1250$
$a/t_i=0.2$ - $G_i=G5$ - Run 751
$a/t_i=0.2$ - $G_i=G6$ - Run 752
$a/t_i=0.4$ - $G_i=G5$ - Run 755
$a/t_i=0.4$ - $G_i=G6$ - Run 756
G
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

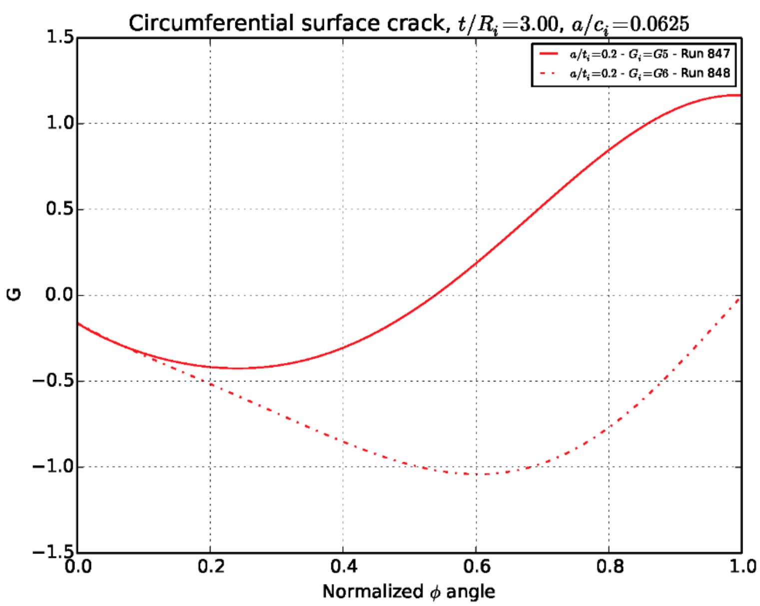


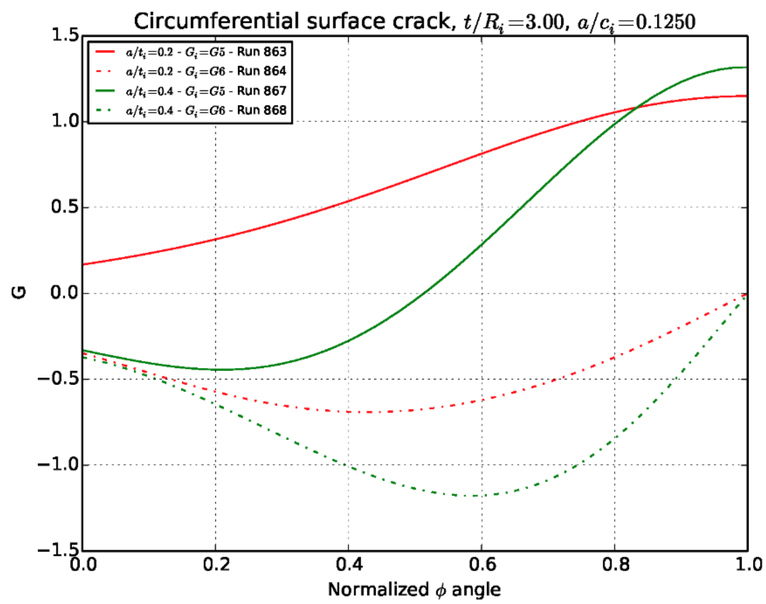
Circumferential surface crack, $t/R_i=2.50$, $a/c_i=0.2500$
$a/t_i=0.2$ - $G_i=G5$ - Run 767
$a/t_i=0.2$ - $G_i=G6$ - Run 768
$a/t_i=0.4$ - $G_i=G5$ - Run 771
$a/t_i=0.4$ - $G_i=G6$ - Run 772
$a/t_i=0.6$ - $G_i=G5$ - Run 775
$a/t_i=0.6$ - $G_i=G6$ - Run 776
$a/t_i=0.8$ - $G_i=G5$ - Run 779
$a/t_i=0.8$ - $G_i=G6$ - Run 780
G
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0.0
0.2
0.4
0.6
0.8
1.0
Normalized ϕ angle

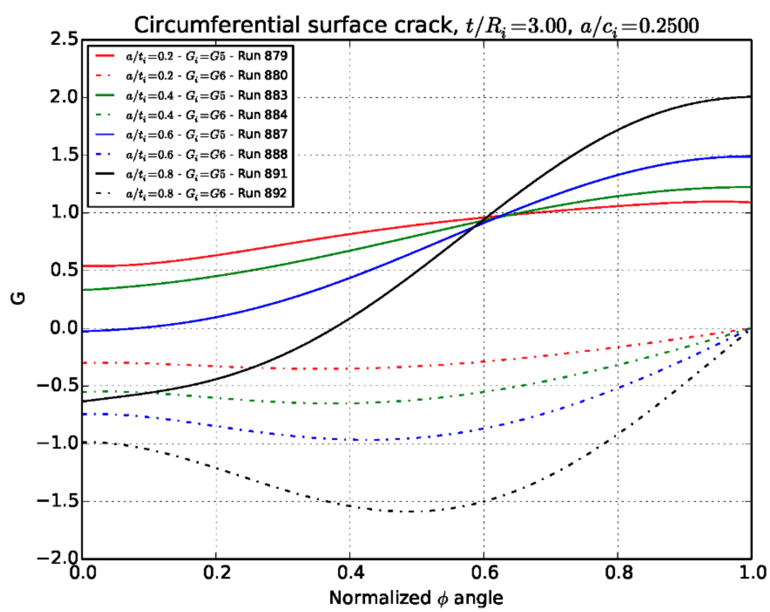

Circumferential surface crack, $t/R_i=2.50$, $a/c_i=0.5000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=$G5$ - Run 783
a/t_i=0.2 - G_i=$G6$ - Run 784
a/t_i=0.4 - G_i=$G5$ - Run 787
a/t_i=0.4 - G_i=$G6$ - Run 788
a/t_i=0.6 - G_i=$G5$ - Run 791
a/t_i=0.6 - G_i=$G6$ - Run 792
a/t_i=0.8 - G_i=$G5$ - Run 795
a/t_i=0.8 - G_i=$G6$ - Run 796
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
0.2
0.4
0.6
0.8
1.0

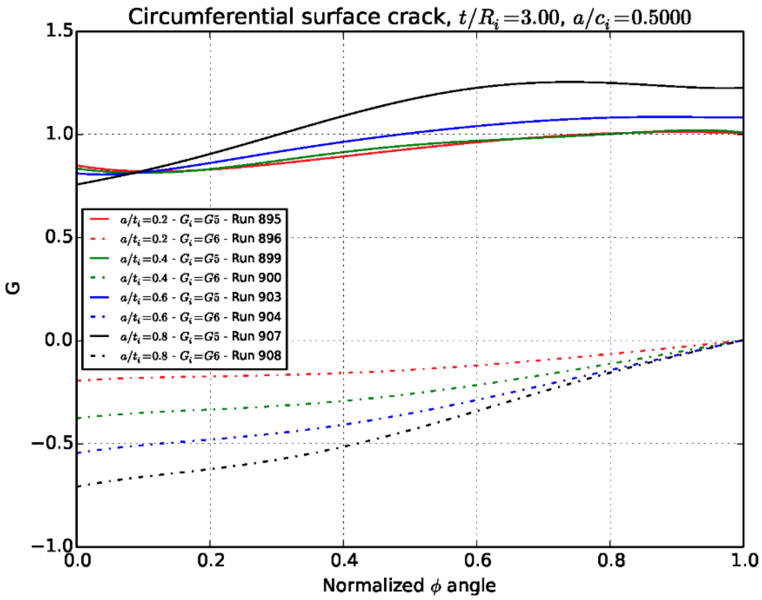

Circumferential surface crack, $t/R_i=2.50$, $a/c_i=1.0000$
G
Normalized ϕ angle
a/t_i=0.2 - G_i=$G5$ - Run 799
a/t_i=0.2 - G_i=$G6$ - Run 800
a/t_i=0.4 - G_i=$G5$ - Run 803
a/t_i=0.4 - G_i=$G6$ - Run 804
a/t_i=0.6 - G_i=$G5$ - Run 807
a/t_i=0.6 - G_i=$G6$ - Run 808
a/t_i=0.8 - G_i=$G5$ - Run 811
a/t_i=0.8 - G_i=$G6$ - Run 812
1.5
1.0
0.5
0.0
−0.5
0.0
0.2
0.4
0.6
0.8
1.0

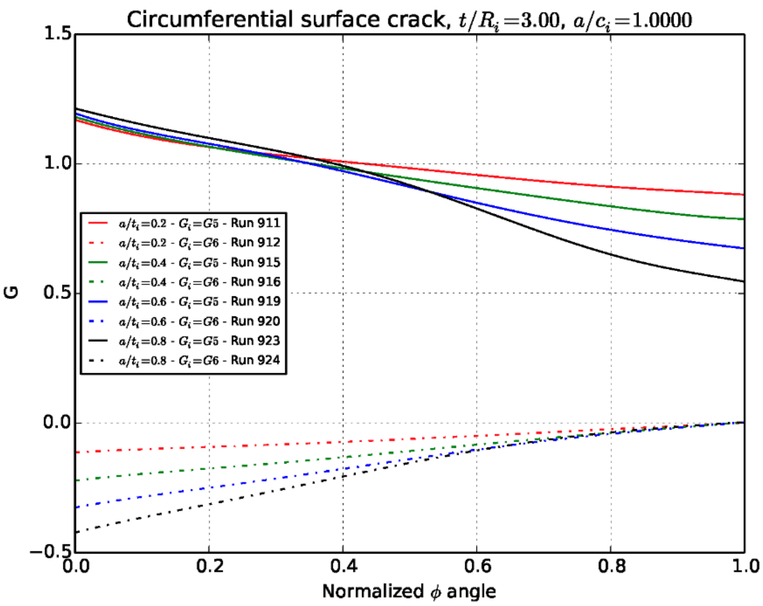

Circumferential surface crack, t/Ri=2.50, a/ci=2.0000
a/ti=0.2 - Gi=G5 - Run 815
a/ti=0.2 - Gi=G6 - Run 816
a/ti=0.4 - Gi=G5 - Run 819
a/ti=0.4 - Gi=G6 - Run 820
a/ti=0.6 - Gi=G5 - Run 823
a/ti=0.6 - Gi=G6 - Run 824
a/ti=0.8 - Gi=G5 - Run 827
a/ti=0.8 - Gi=G6 - Run 828
G
Normalized φ angle

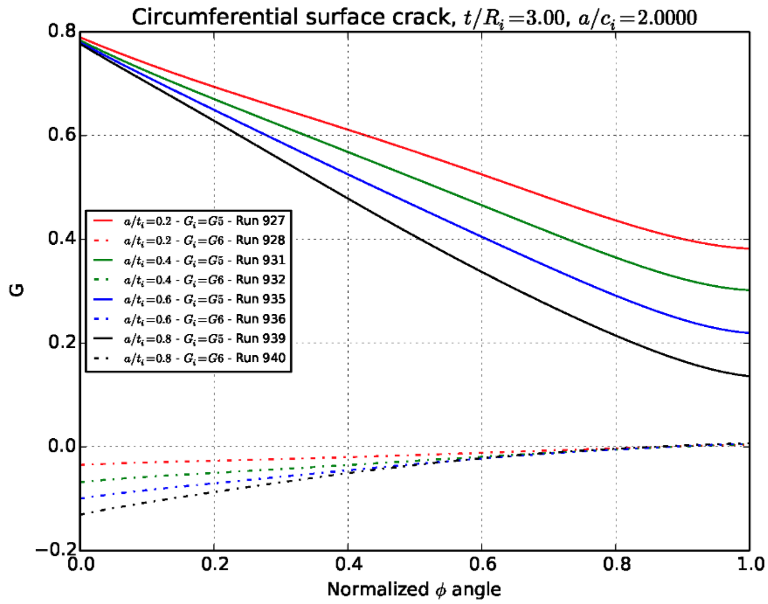

Circumferential surface crack, t/Ri=3.00, a/ci=0.0625
a/ti=0.2 - Gi=G5 - Run 847
a/ti=0.2 - Gi=G6 - Run 848
G
Normalized φ angle


Circumferential surface crack, $t/R_i=3.00$, $a/c_i=0.1250$
$a/t_i=0.2$ - $G_i=G5$ - Run 863
$a/t_i=0.2$ - $G_i=G6$ - Run 864
$a/t_i=0.4$ - $G_i=G5$ - Run 867
$a/t_i=0.4$ - $G_i=G6$ - Run 868
G
Normalized ϕ angle


Circumferential surface crack, $t/R_i=3.00$, $a/c_i=0.2500$
$a/t_i=0.2$ - $G_i=G5$ - Run 879
$a/t_i=0.2$ - $G_i=G6$ - Run 880
$a/t_i=0.4$ - $G_i=G5$ - Run 883
$a/t_i=0.4$ - $G_i=G6$ - Run 884
$a/t_i=0.6$ - $G_i=G5$ - Run 887
$a/t_i=0.6$ - $G_i=G6$ - Run 888
$a/t_i=0.8$ - $G_i=G5$ - Run 891
$a/t_i=0.8$ - $G_i=G6$ - Run 892
G
Normalized ϕ angle

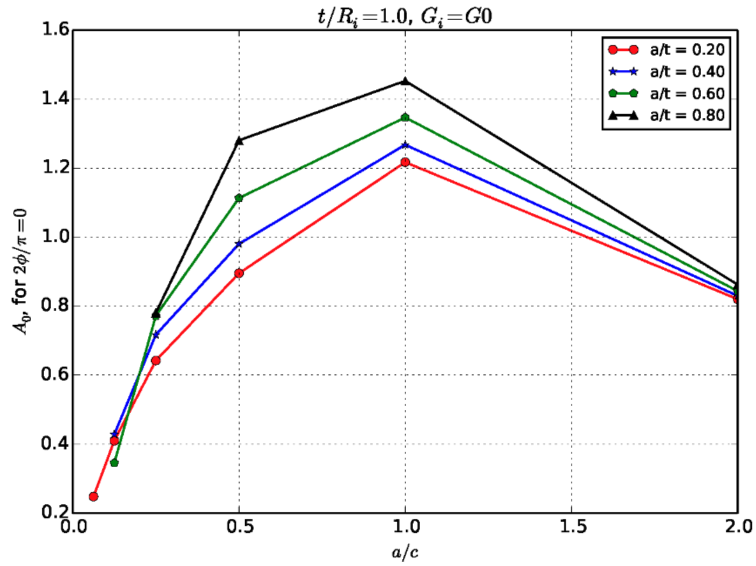

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 0.5000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G5$ - Run 895
$a/t_i=0.2$ - $G_i=G6$ - Run 896
$a/t_i=0.4$ - $G_i=G5$ - Run 899
$a/t_i=0.4$ - $G_i=G6$ - Run 900
$a/t_i=0.6$ - $G_i=G5$ - Run 903
$a/t_i=0.6$ - $G_i=G6$ - Run 904
$a/t_i=0.8$ - $G_i=G5$ - Run 907
$a/t_i=0.8$ - $G_i=G6$ - Run 908

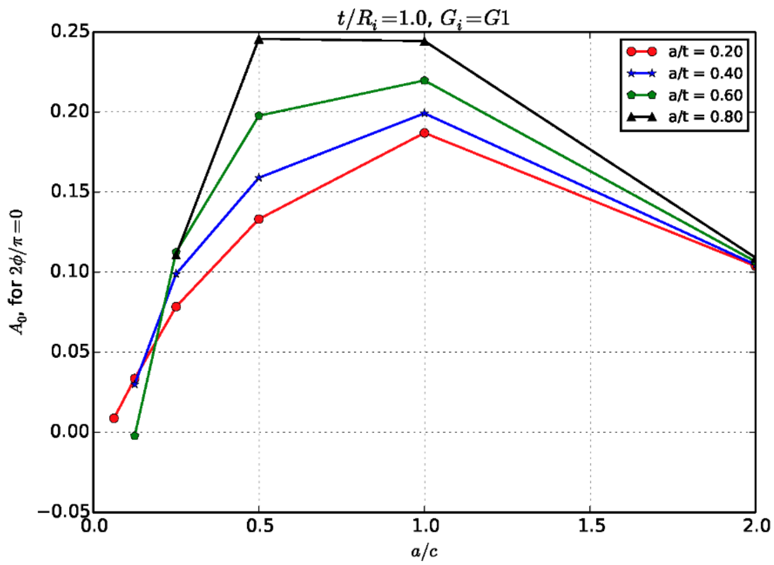

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 1.0000$
G
Normalized ϕ angle
$a/t_i=0.2$ - $G_i=G5$ - Run 911
$a/t_i=0.2$ - $G_i=G6$ - Run 912
$a/t_i=0.4$ - $G_i=G5$ - Run 915
$a/t_i=0.4$ - $G_i=G6$ - Run 916
$a/t_i=0.6$ - $G_i=G5$ - Run 919
$a/t_i=0.6$ - $G_i=G6$ - Run 920
$a/t_i=0.8$ - $G_i=G5$ - Run 923
$a/t_i=0.8$ - $G_i=G6$ - Run 924

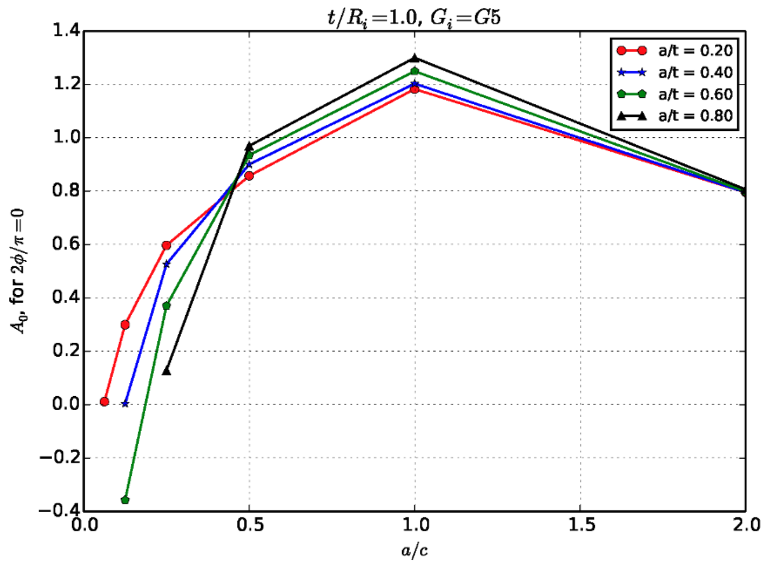

Circumferential surface crack, $t/R_i = 3.00$, $a/c_i = 2.0000$
$a/t_i = 0.2$ - $G_i = G5$ - Run 927
$a/t_i = 0.2$ - $G_i = G6$ - Run 928
$a/t_i = 0.4$ - $G_i = G5$ - Run 931
$a/t_i = 0.4$ - $G_i = G6$ - Run 932
$a/t_i = 0.6$ - $G_i = G5$ - Run 935
$a/t_i = 0.6$ - $G_i = G6$ - Run 936
$a/t_i = 0.8$ - $G_i = G5$ - Run 939
$a/t_i = 0.8$ - $G_i = G6$ - Run 940
G
Normalized ϕ angle
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

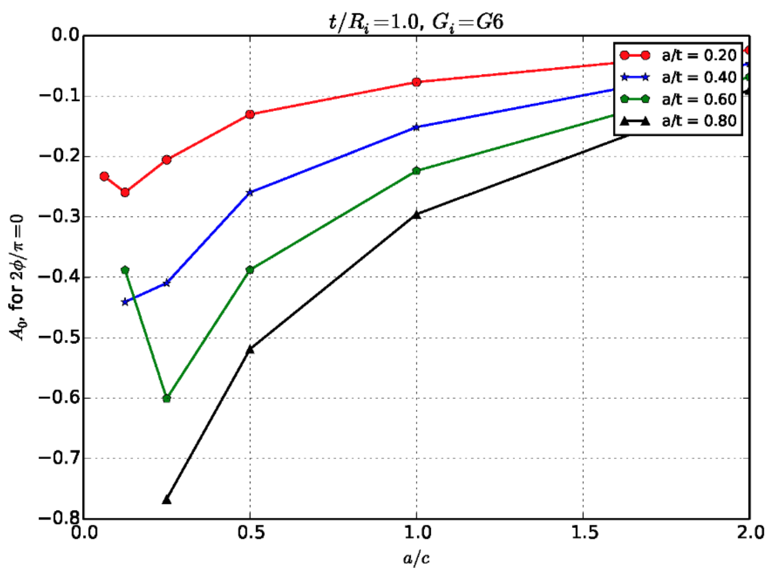
APPENDIX K: CIRCUMFERENTIAL EXTERNAL SURFACE CRACK TREND PLOTS

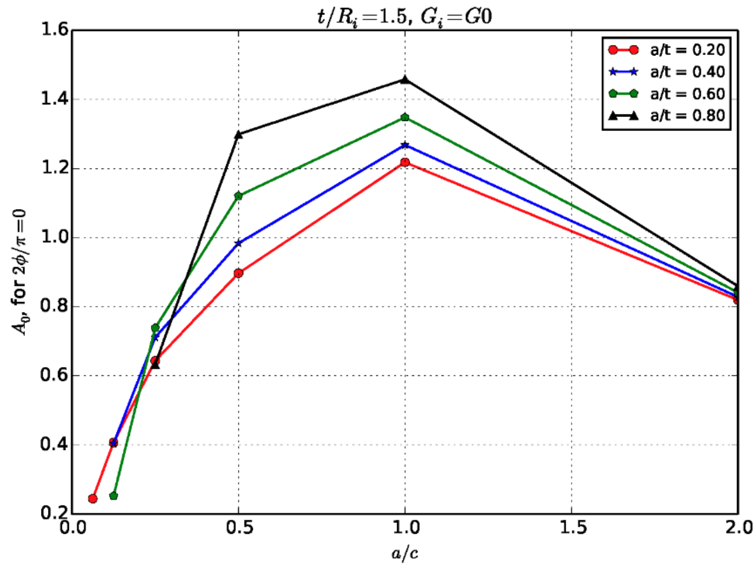
Plots to compare G result trends at the crack tip (at $2\phi/\pi = 0$) and at the crack depth (at $2\phi/\pi = 1$). There are four curves per plot for each a/t ratio; a plot for each load case; 40 plots total. At the crack tip, plot the $G = A_0$ curve-fit coefficient versus the a/c ratio; see the first 20 plots. At the crack depth, plot the sum of the curve-fit coefficient values: $G = \Sigma A_i$; see the last 20 plots.

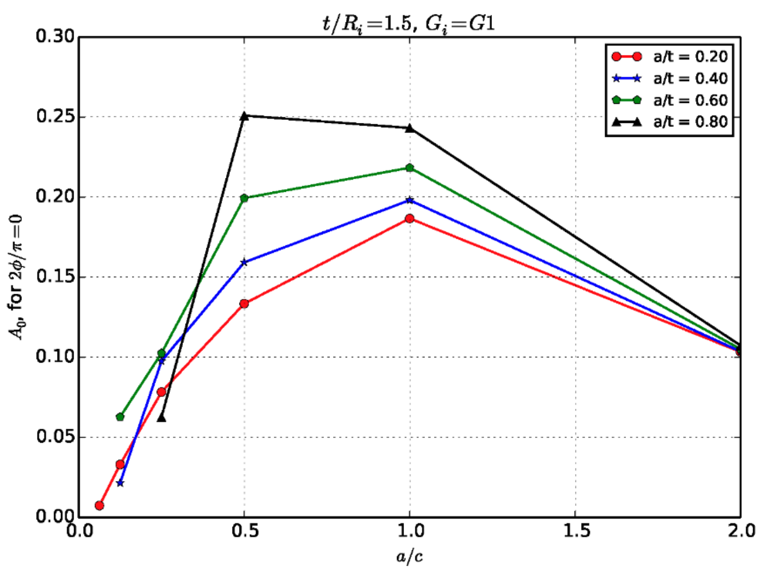


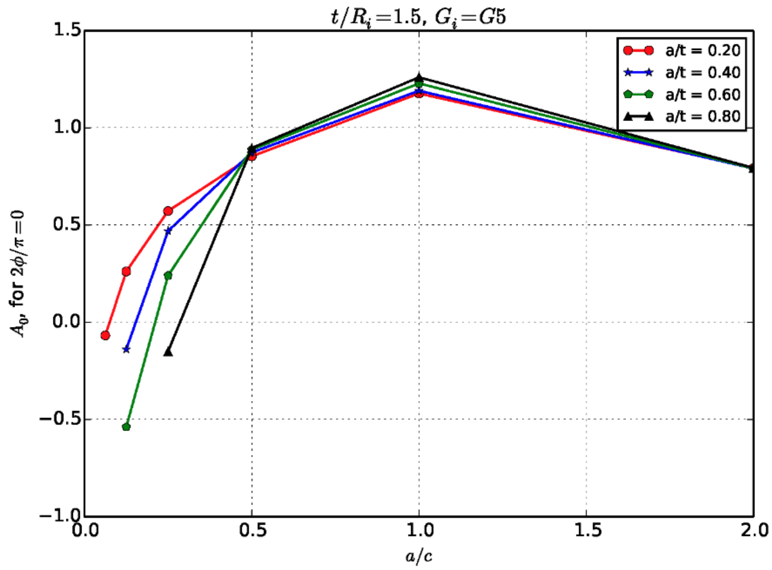


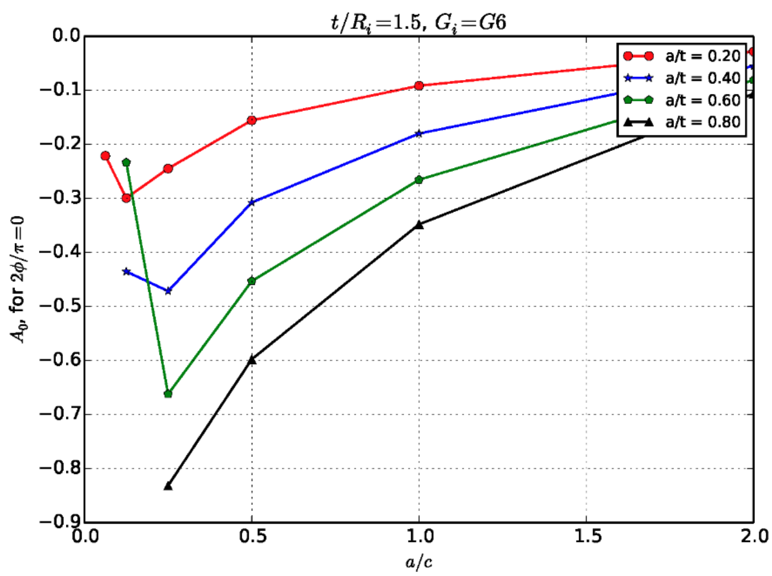

$t/R_i = 1.0,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

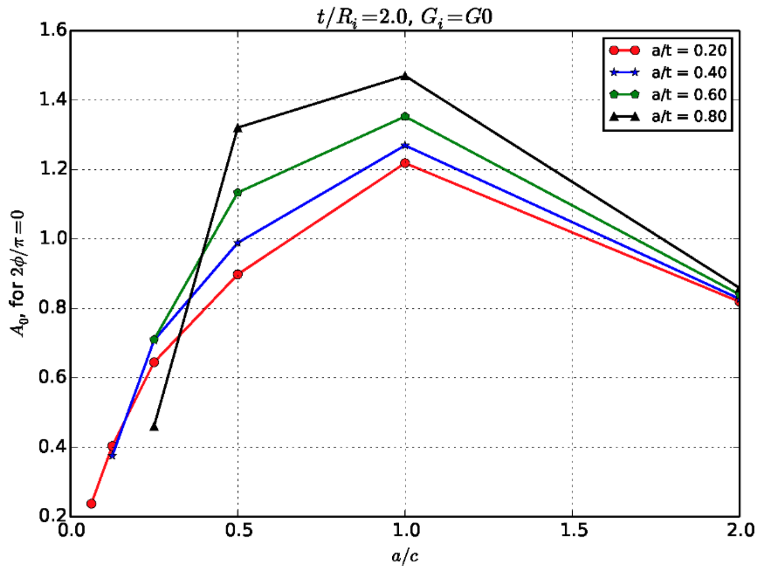

$t/R_i = 1.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

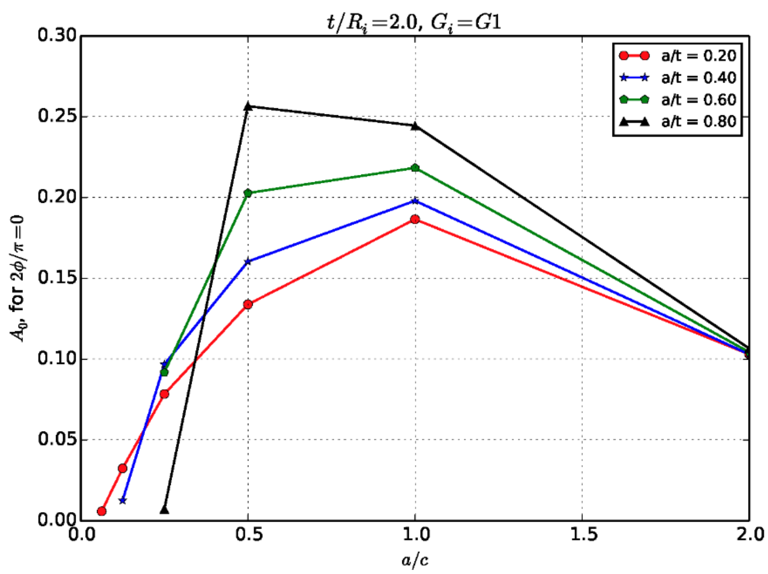

$t/R_i = 1.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

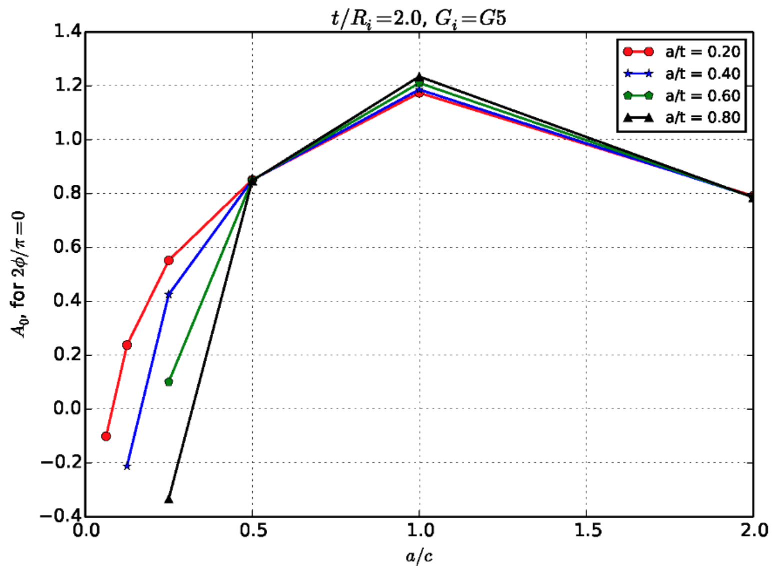

$t/R_i = 1.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c


$t/R_i = 1.5,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
0.5
1.0
1.5
2.0

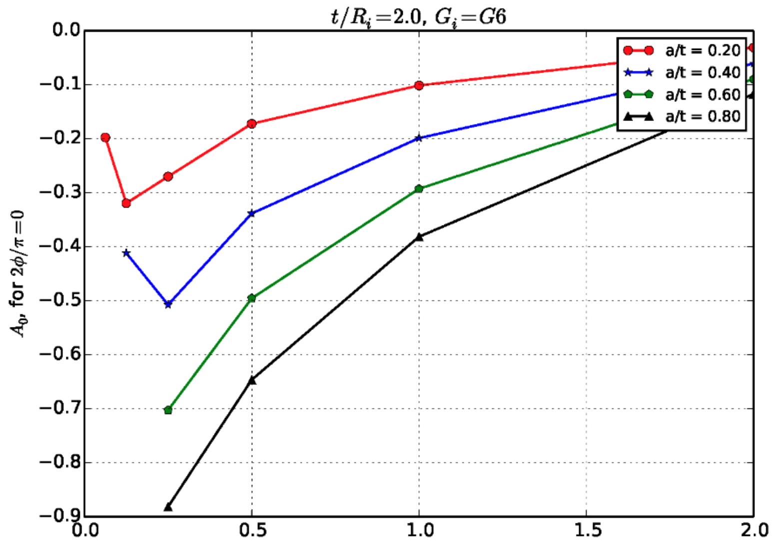

$t/R_i = 1.5,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
0.0
0.5
1.0
1.5
2.0

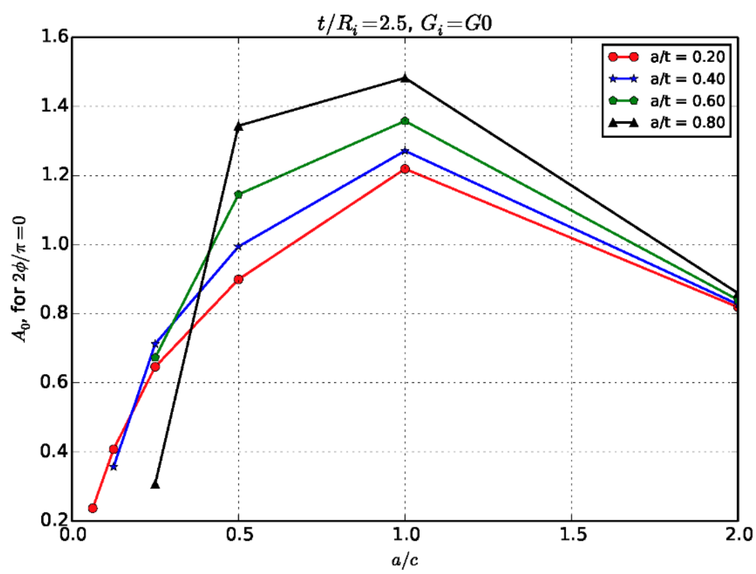

$t/R_i = 2.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

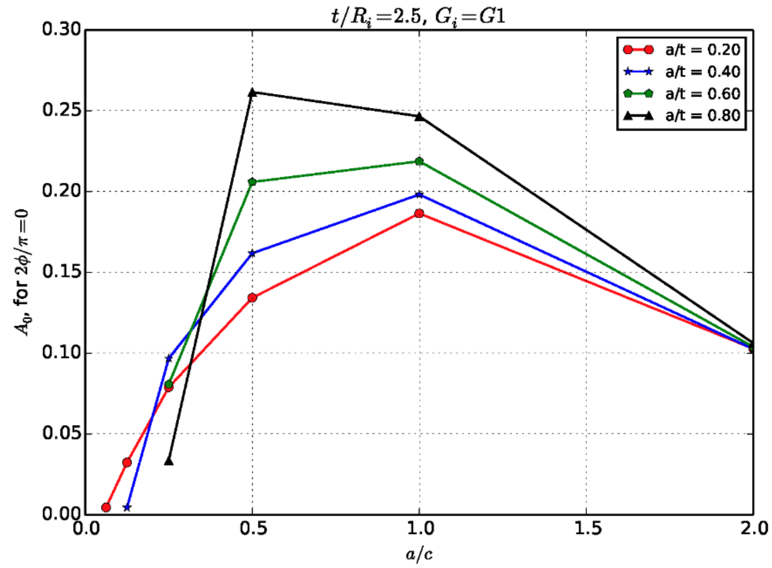

$t/R_i = 2.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

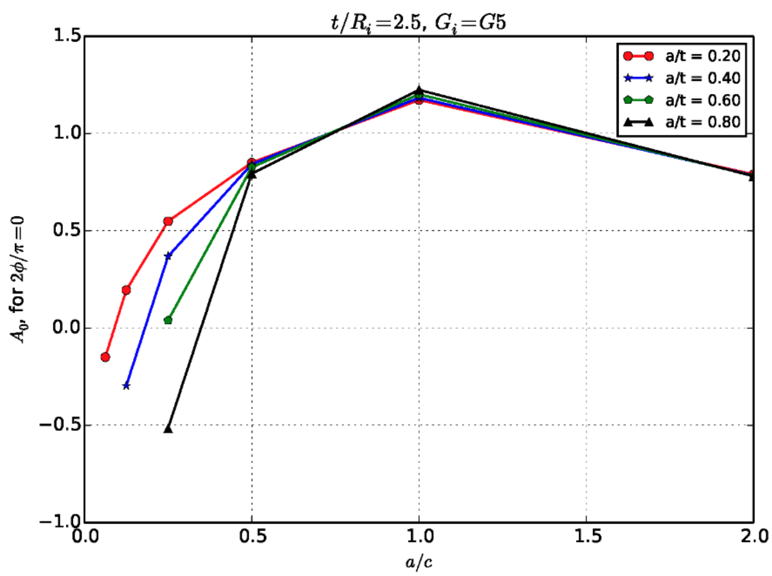


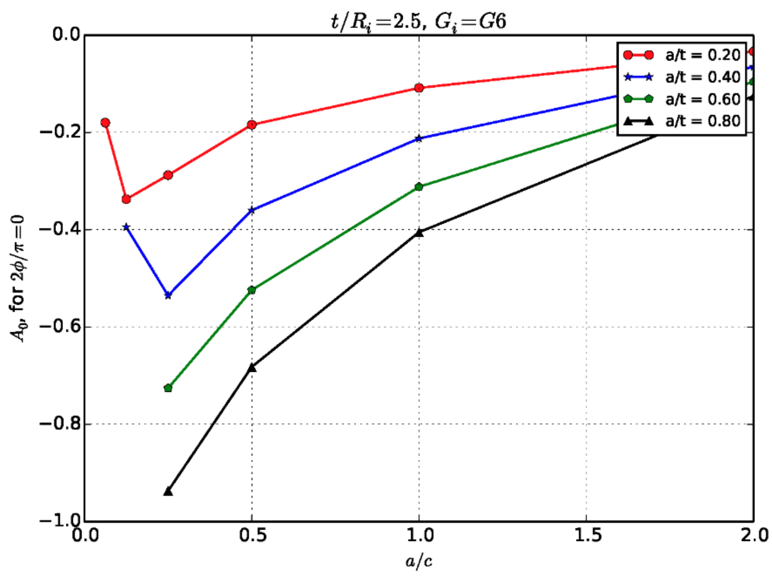
$t/R_i = 2.0,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_φ, for $2\phi/\pi = 0$
a/c
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0.0
0.5
1.0
1.5
2.0

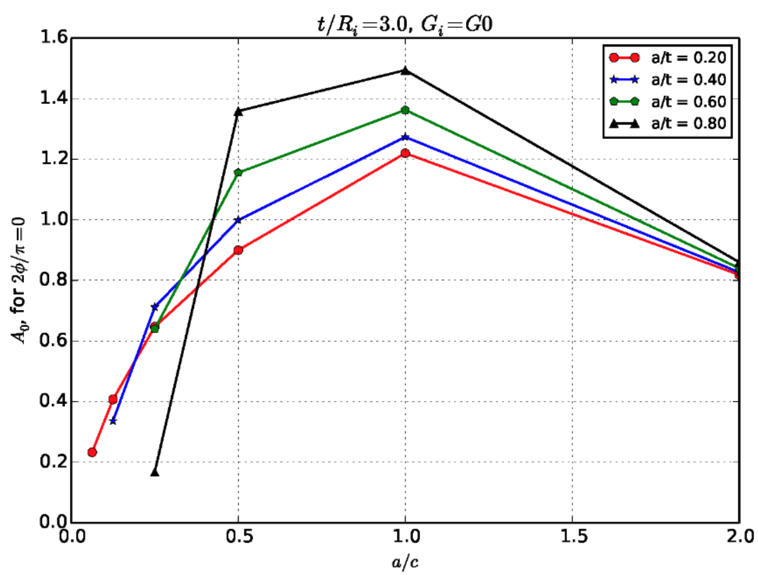

$t/R_i = 2.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$

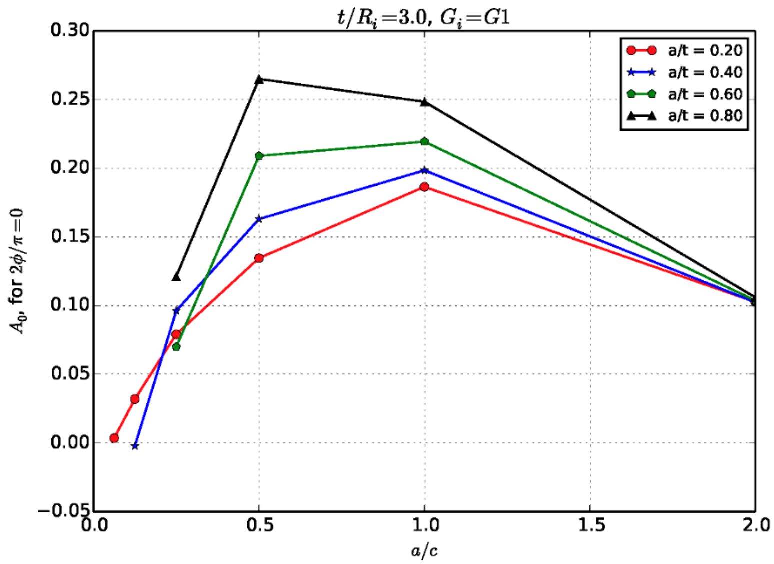

$t/R_i = 2.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

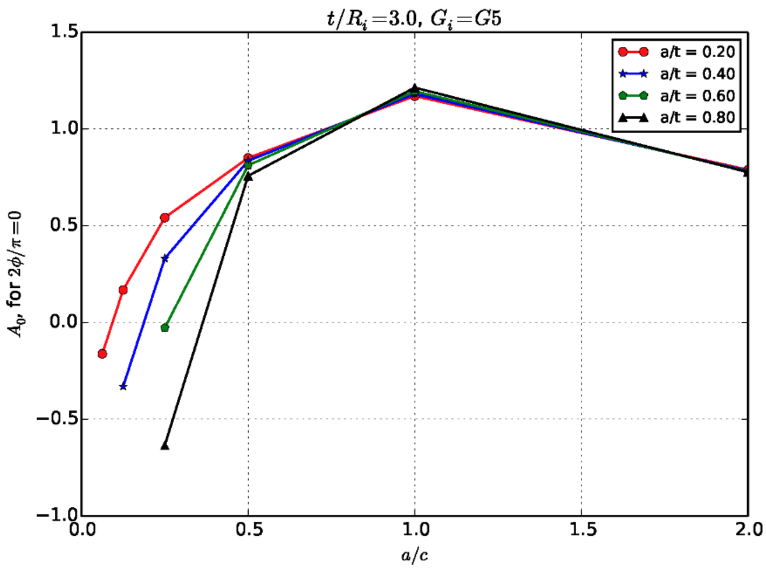

$t/R_i = 2.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0

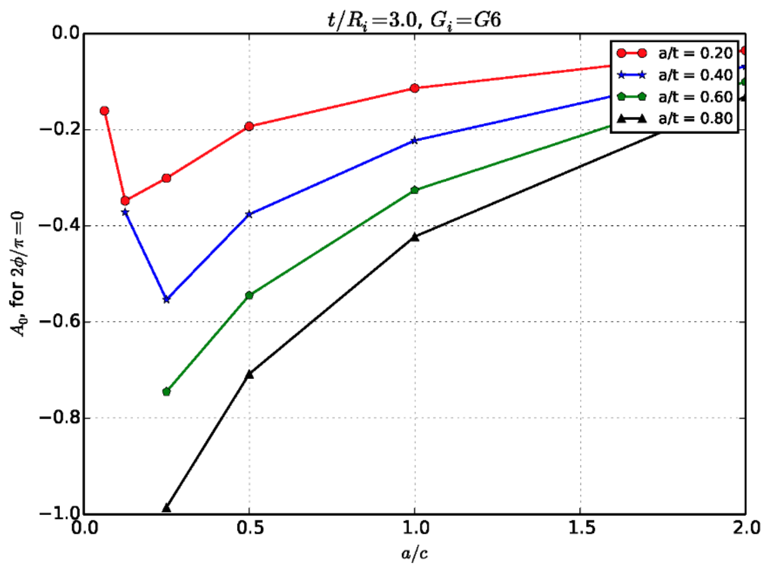

$t/R_i = 2.5,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
0.5
1.0
1.5
2.0

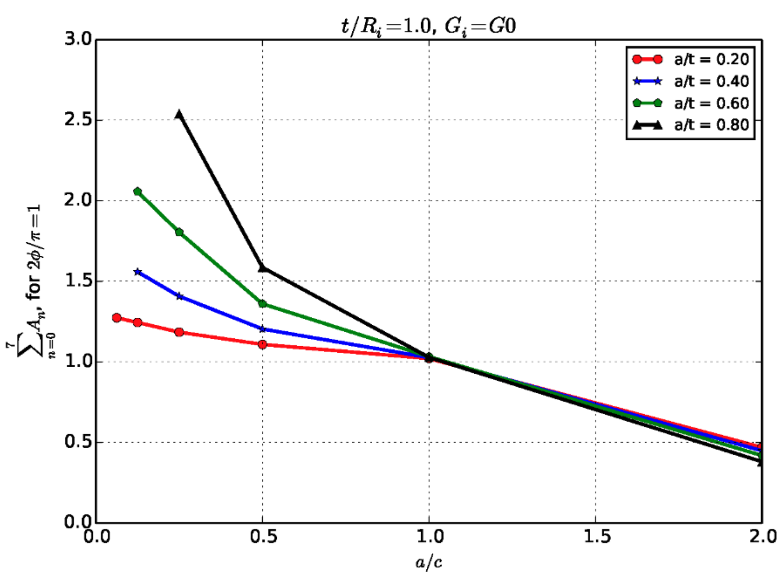

$t/R_i = 2.5,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

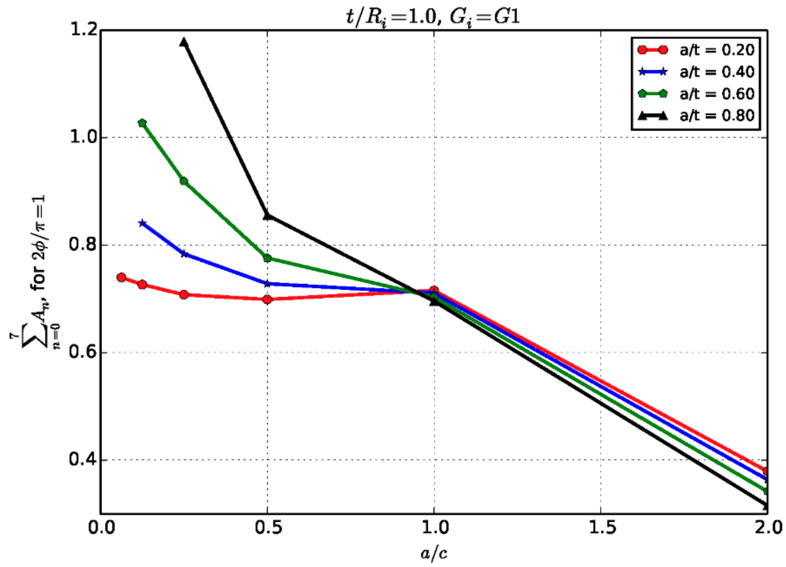

$t/R_i = 3.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c

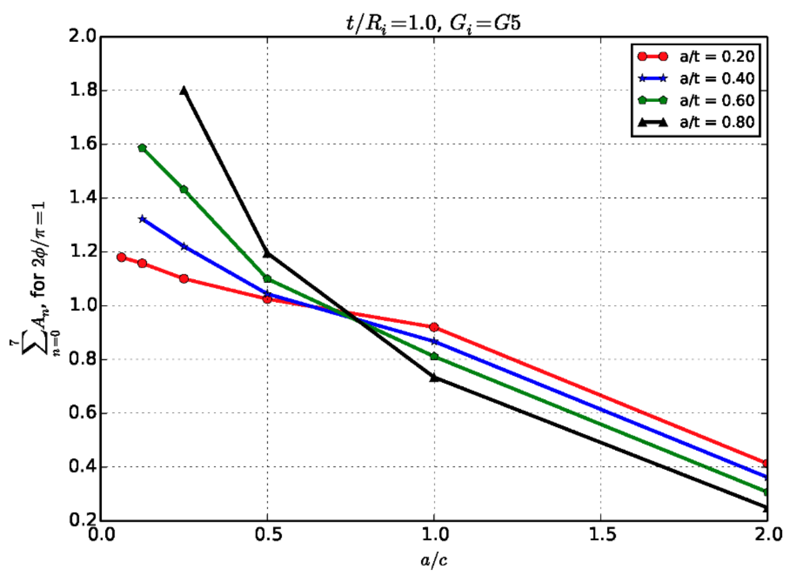

$t/R_i = 3.0,\ G_i = G1$
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
0.0
0.5
1.0
1.5
2.0
A_0, for $2\phi/\pi = 0$
a/c
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80

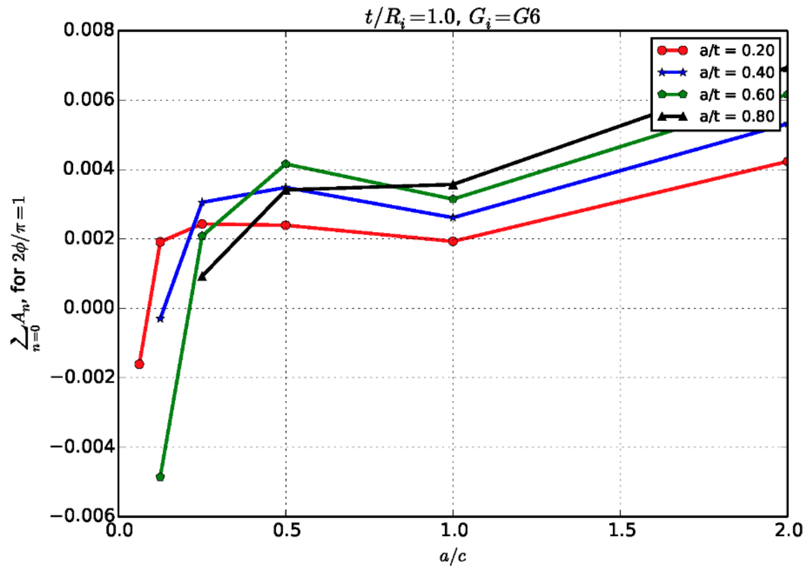

$t/R_i = 3.0,\ G_i = G5$
1.5
1.0
0.5
0.0
−0.5
−1.0
0.0
0.5
1.0
1.5
2.0
A_0, for $2\phi/\pi = 0$
a/c
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80

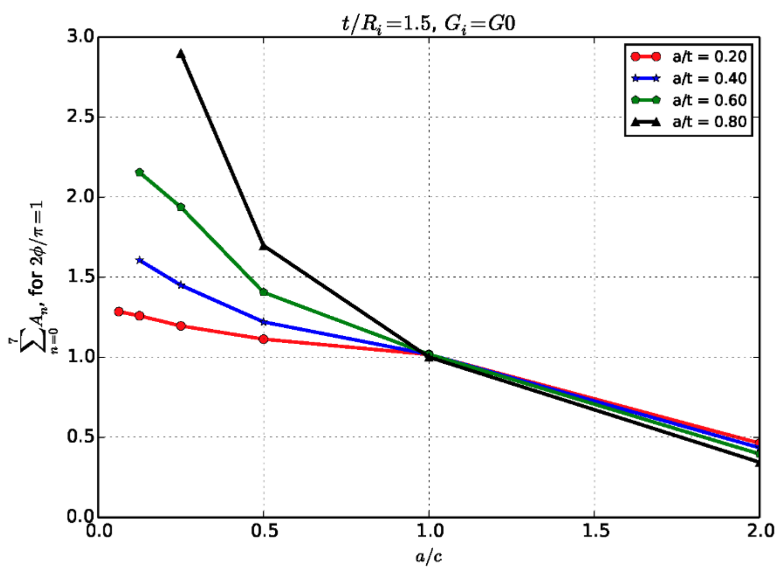

$t/R_i = 3.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
A_0, for $2\phi/\pi = 0$
a/c
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
0.0
0.5
1.0
1.5
2.0

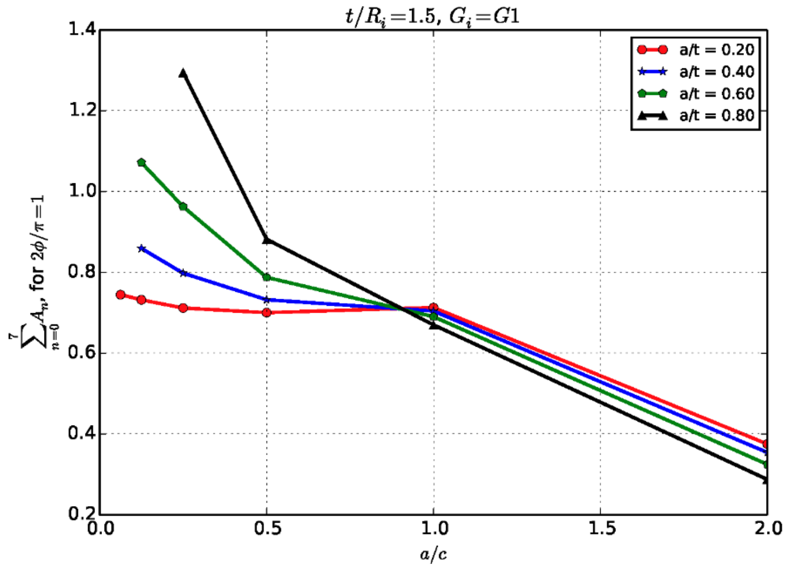

$t/R_i = 1.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

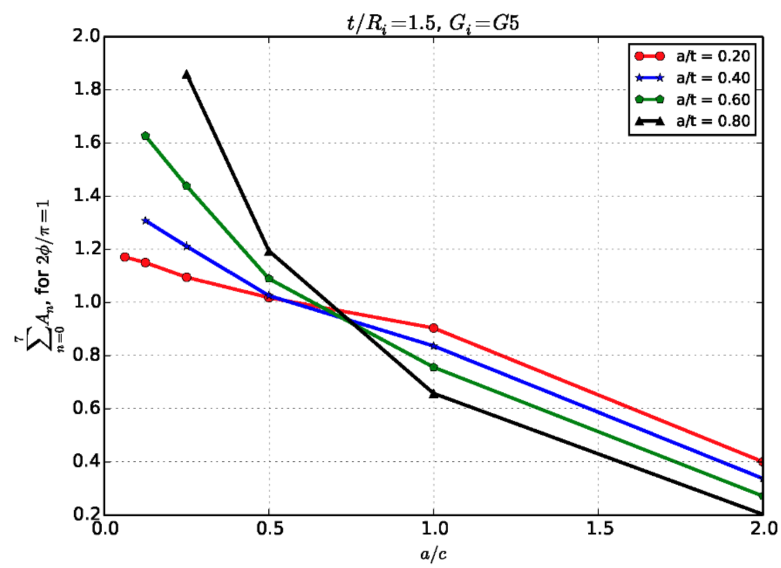

$t/R_i = 1.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.0
0.5
1.0
1.5
2.0
0.4
0.6
0.8
1.0
1.2

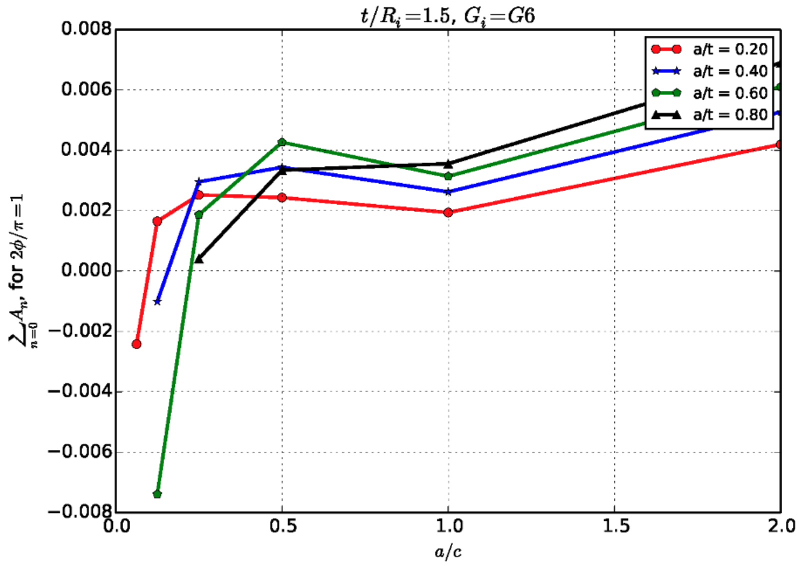

$t/R_i = 1.0,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.0
0.5
1.0
1.5
2.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0

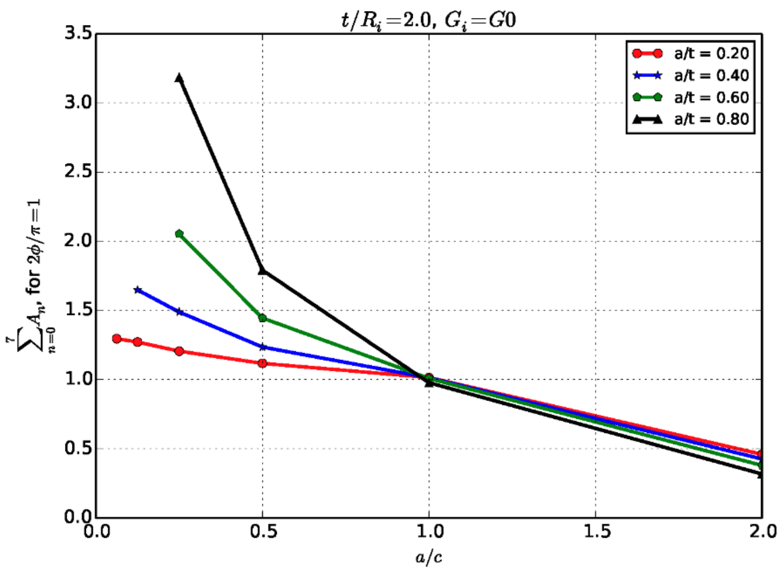

$t/R_i = 1.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0} A_n$, for $2\phi/\pi = 1$
a/c
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
−0.006
0.0
0.5
1.0
1.5
2.0

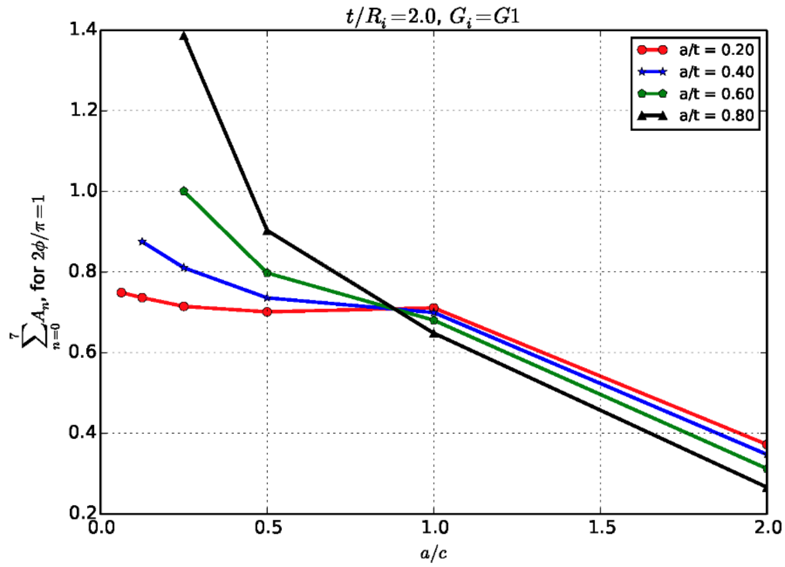

$t/R_i = 1.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

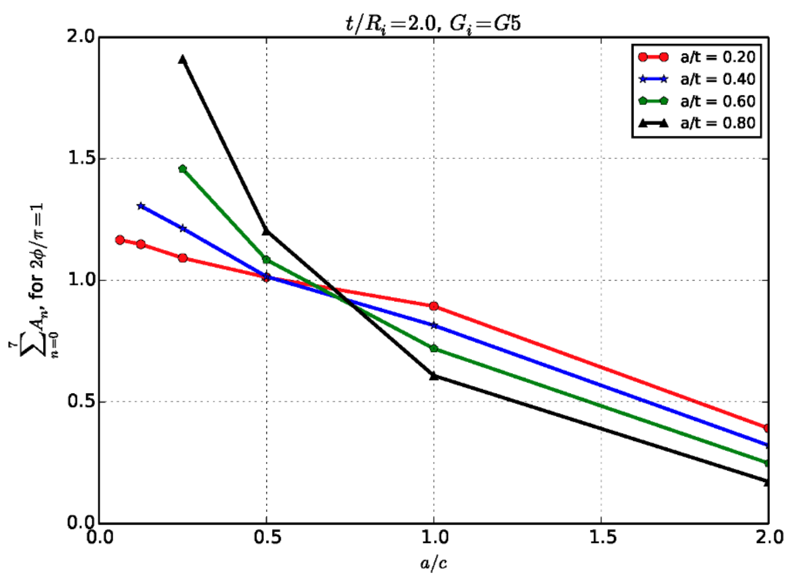

$t/R_i = 1.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.5
1.0
1.5
2.0

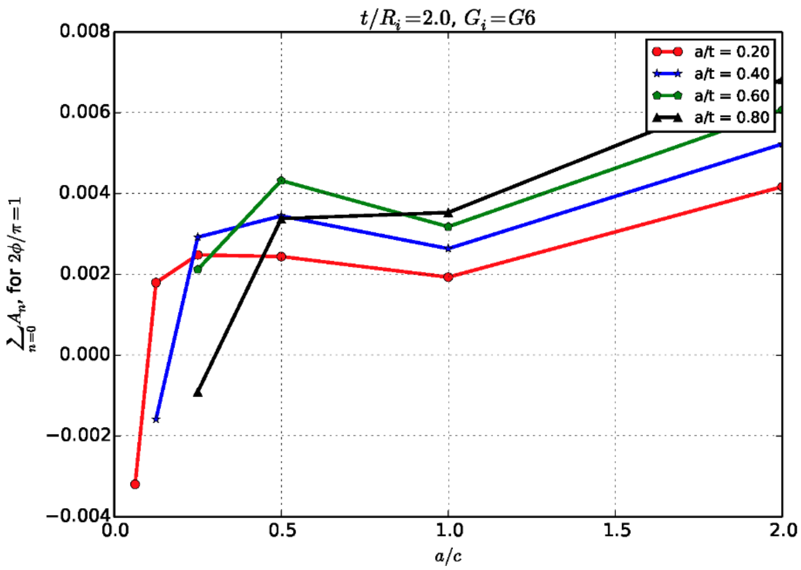

$t/R_i = 1.5,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
0.0
0.5
1.0
1.5
2.0

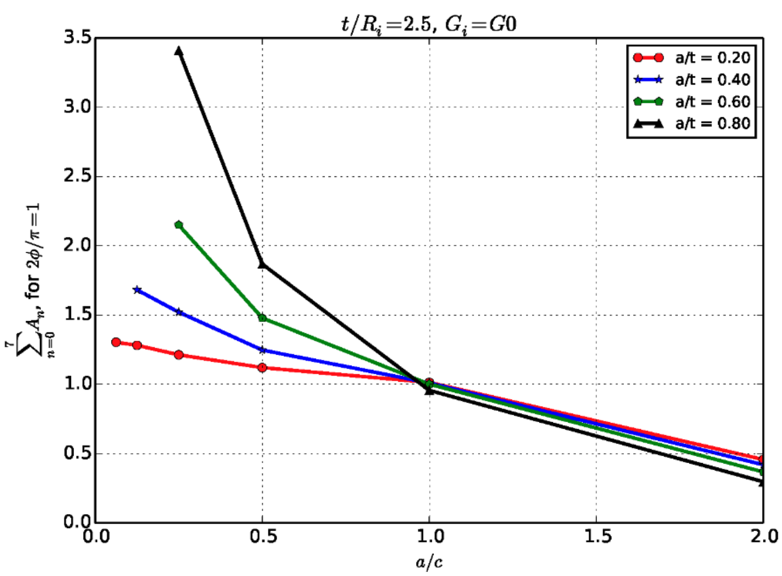

$t/R_i = 1.5,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0} A_n$, for $2\phi/\pi = 1$
a/c
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
−0.006
−0.008
0.0
0.5
1.0
1.5
2.0

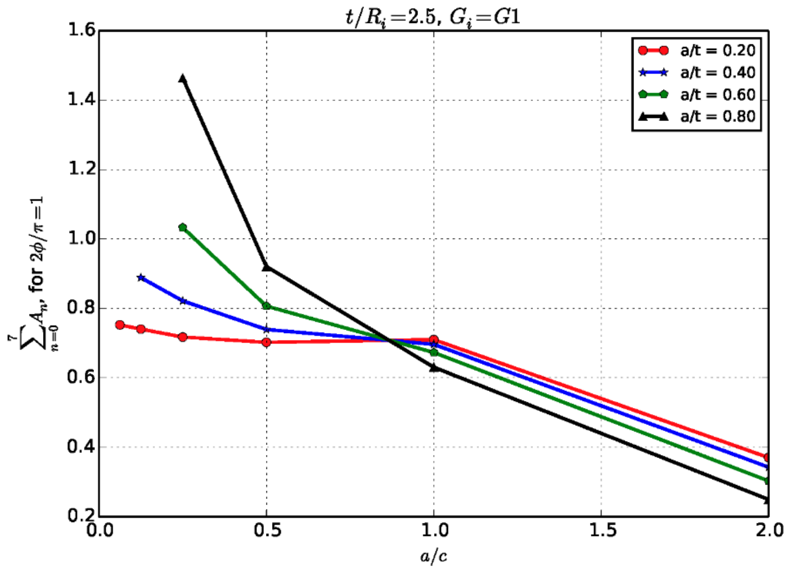

$t/R_i = 2.0,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

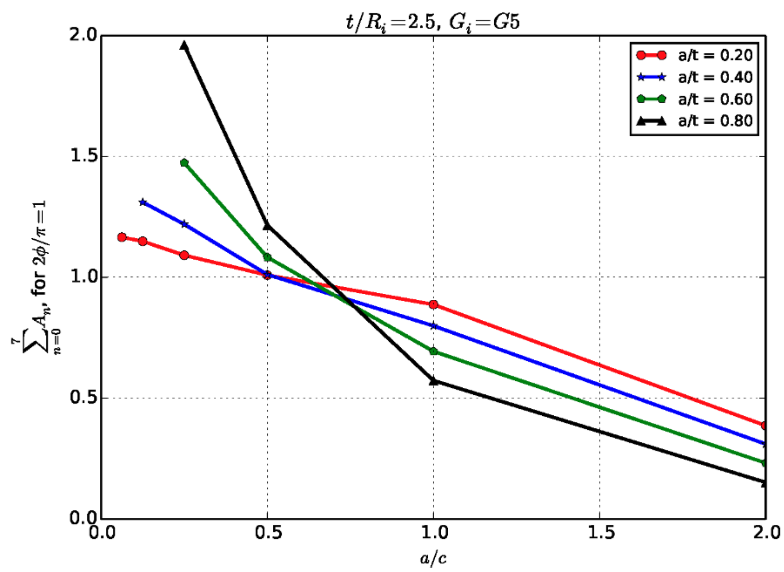

$t/R_i = 2.0,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.5
1.0
1.5
2.0

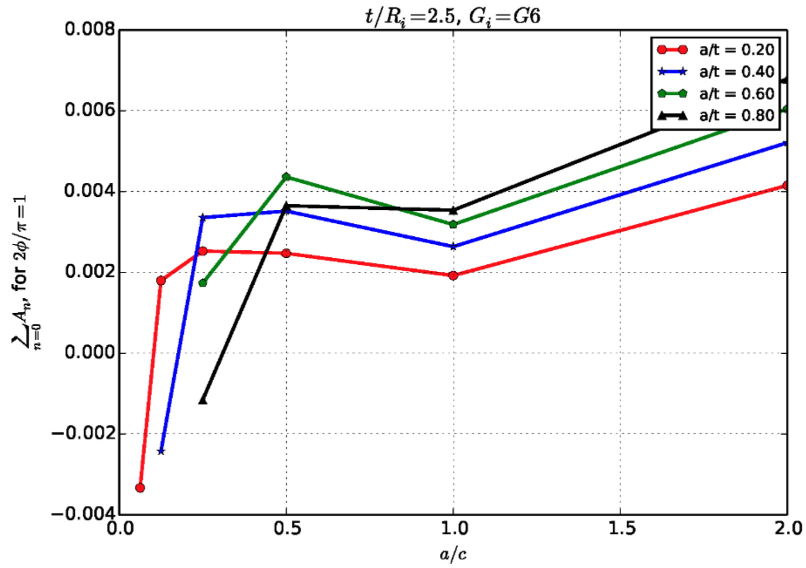

$t/R_i = 2.0,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

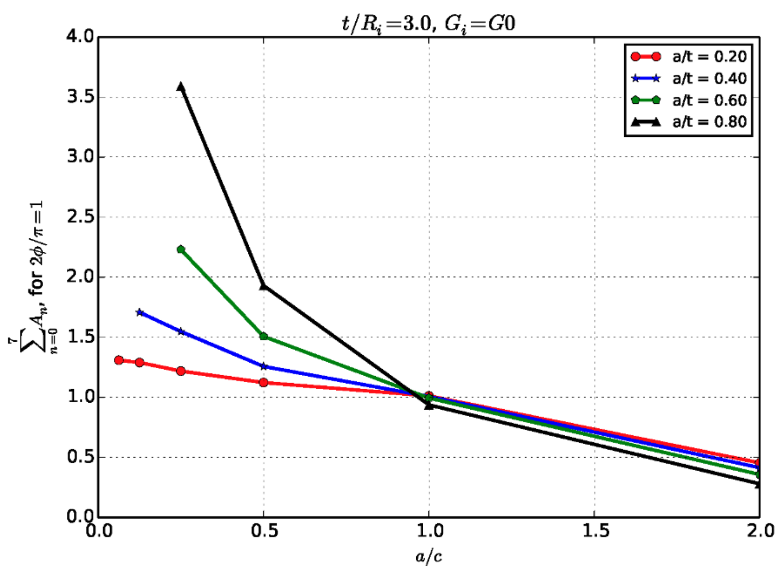

$t/R_i = 2.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0} A_n$, for $2\phi/\pi = 1$
a/c
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
0.0
0.5
1.0
1.5
2.0

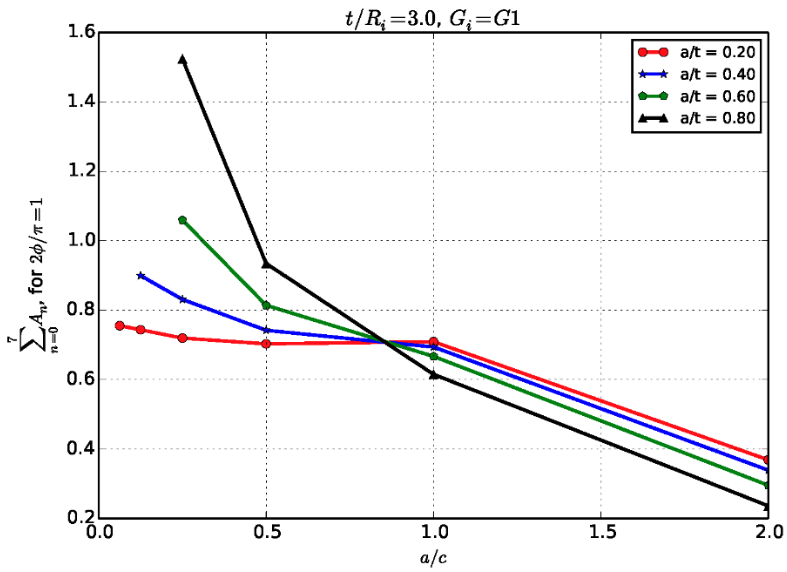

$t/R_i = 2.5,\ G_i = G0$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

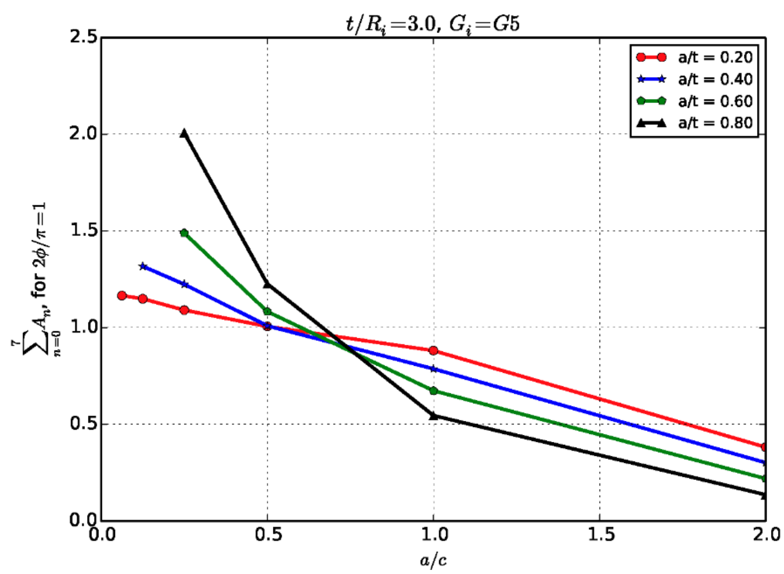

$t/R_i = 2.5,\ G_i = G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.0
0.5
1.0
1.5
2.0

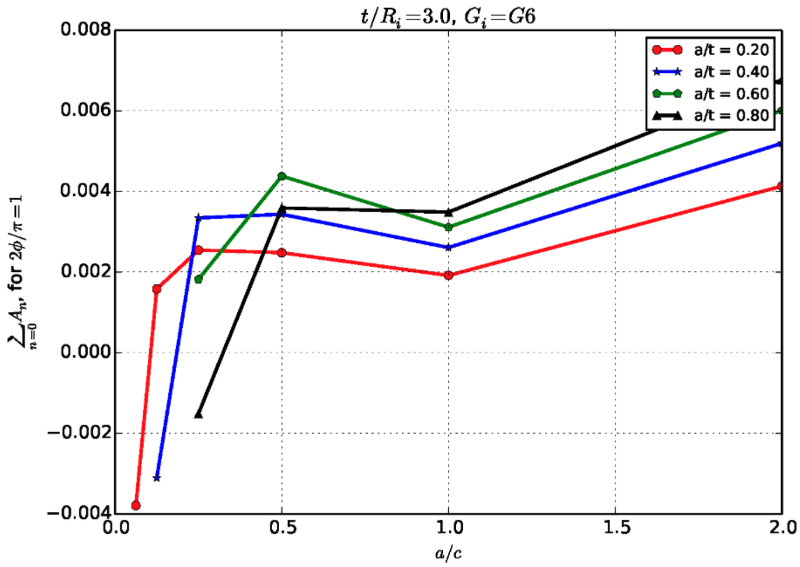

$t/R_i = 2.5,\ G_i = G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/c
0.0
0.5
1.0
1.5
2.0
0.0
0.5
1.0
1.5
2.0


$t/R_i = 2.5,\ G_i = G6$
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
0.0
0.5
1.0
1.5
2.0
a/c
$\sum_{n=0} A_n$, for $2\phi/\pi = 1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80


$t/R_i = 3.0,\ G_i = G0$
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
a/c
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi = 1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80


$t/R_i=3.0,\ G_i=G1$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi=1$
a/c
0.0
0.5
1.0
1.5
2.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6

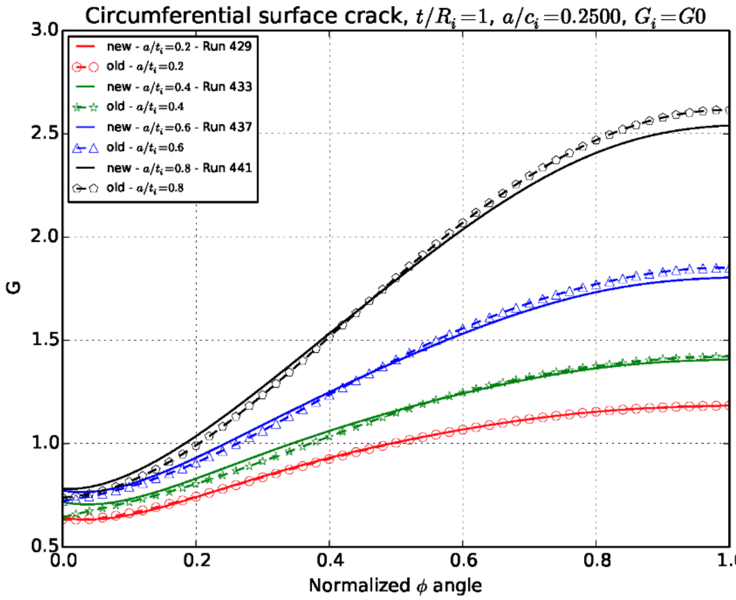

$t/R_i=3.0,\ G_i=G5$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0}^{7} A_n$, for $2\phi/\pi=1$
a/c
0.0
0.5
1.0
1.5
2.0
0.0
0.5
1.0
1.5
2.0
2.5

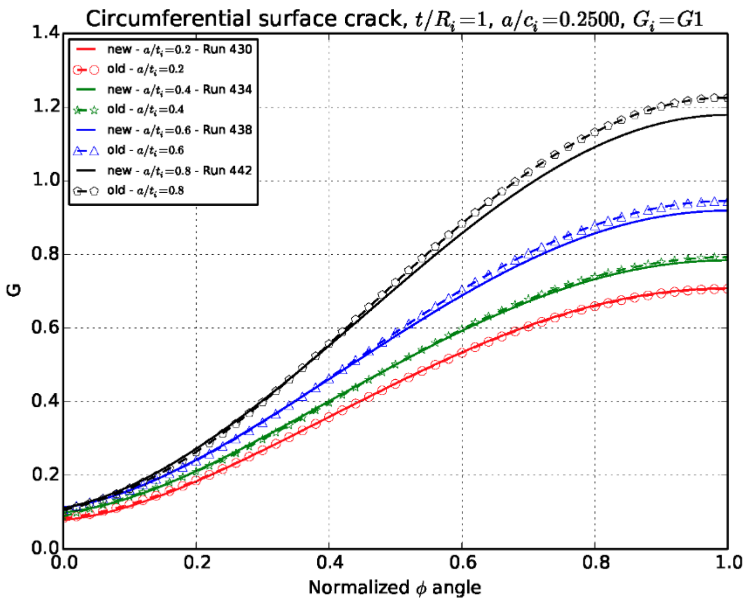


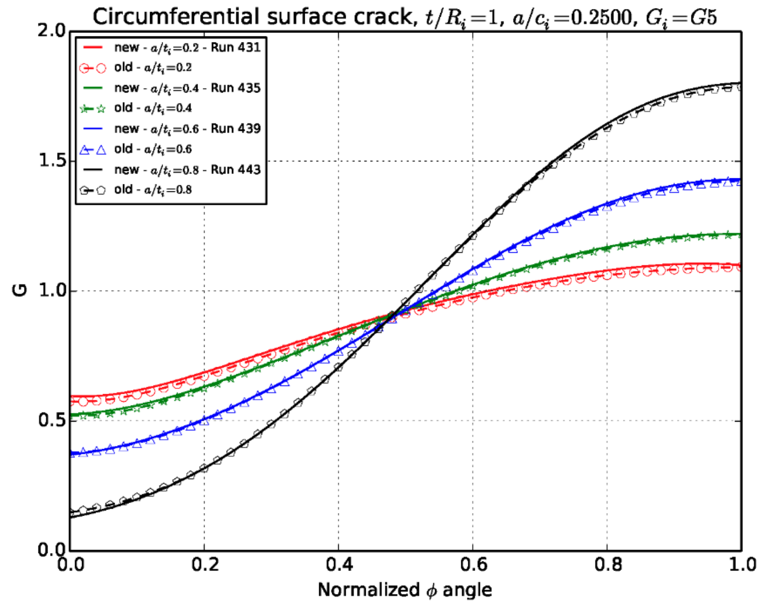
$t/R_i = 3.0,\ G_i = G6$
a/t = 0.20
a/t = 0.40
a/t = 0.60
a/t = 0.80
$\sum_{n=0} A_n$, for $2\phi/\pi = 1$
a/c
0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
0.0
0.5
1.0
1.5
2.0

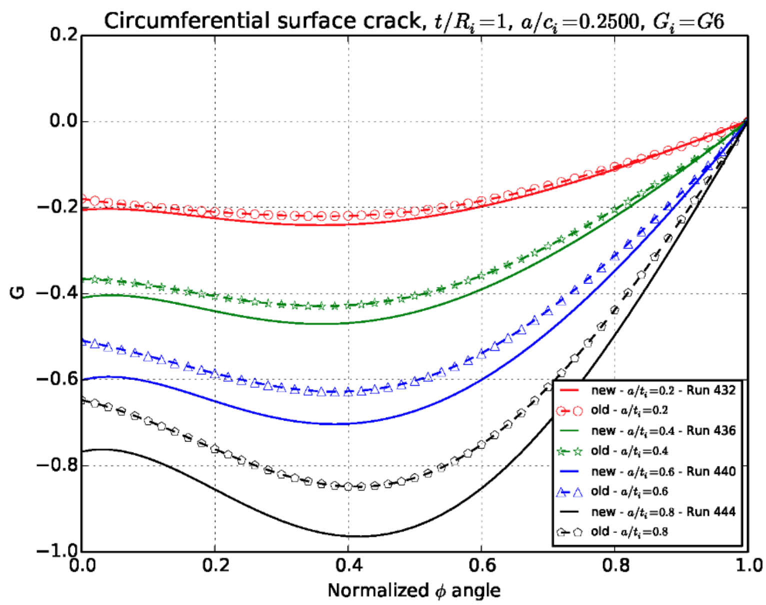
APPENDIX L: CIRCUMFERENTIAL EXTERNAL SURFACE CRACK COMPARISON TO PREVIOUS RESULTS

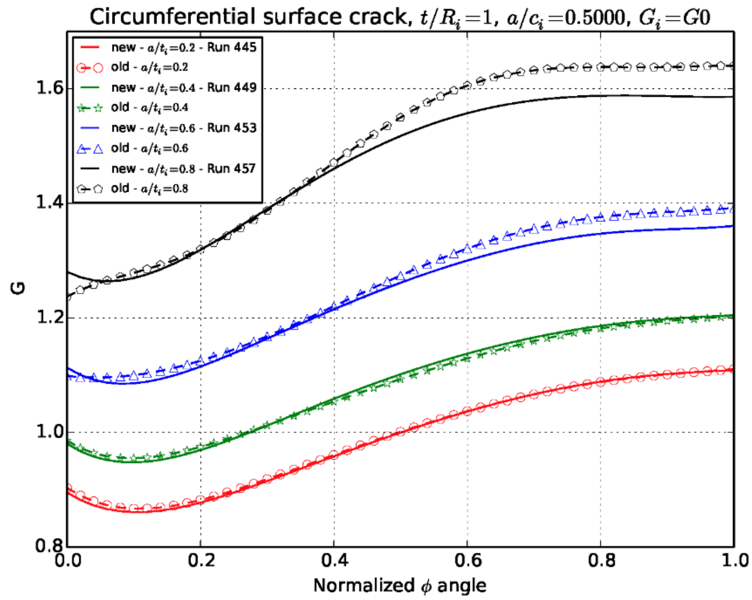
Plots to compare G results for the t/Ri=1 ratio from the previous results to the new results. Plot curves with data points and dashed lines show the previous results, and plot curves with solid lines show the new results; 16 plots total. Generally good agreement, but one exception is case 463 (t/Ri=1, a/c=1.0, a/t=0.2), see Section 7.4 for explanation. The previous results were obtained from API 579, Annex C, Table C.15 [1].

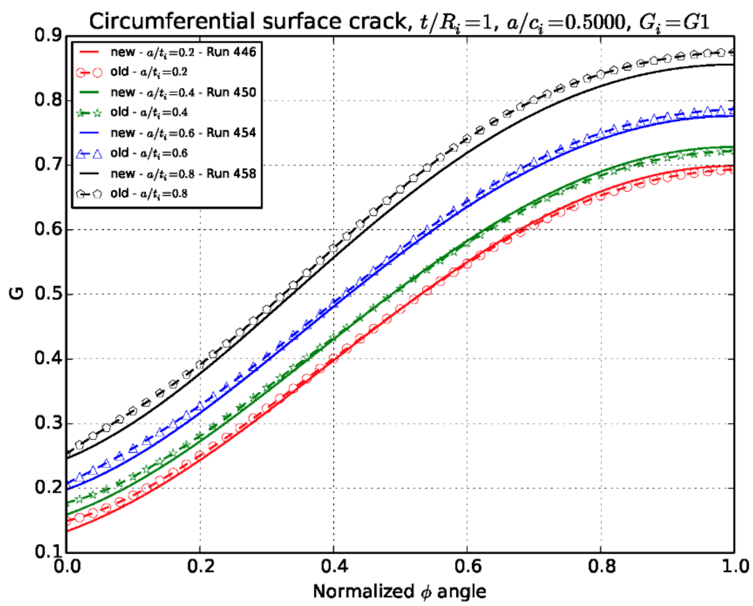


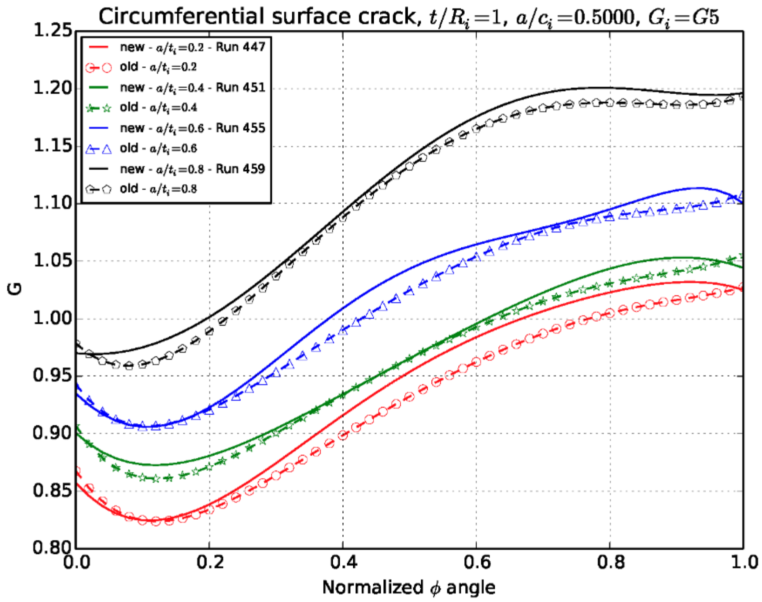


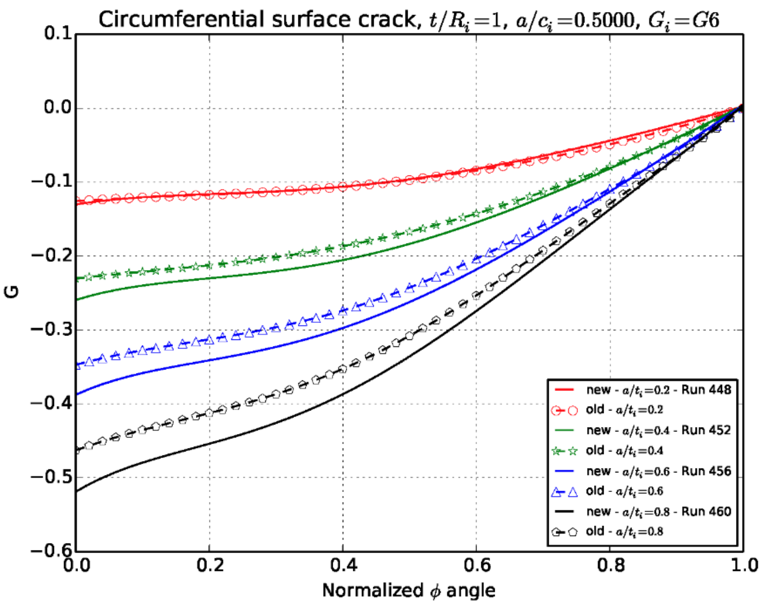

Circumferential surface crack, $t/R_i = 1$, $a/c_i = 0.2500$, $G_i = G5$
new - $a/t_i = 0.2$ - Run 431
old - $a/t_i = 0.2$
new - $a/t_i = 0.4$ - Run 435
old - $a/t_i = 0.4$
new - $a/t_i = 0.6$ - Run 439
old - $a/t_i = 0.6$
new - $a/t_i = 0.8$ - Run 443
old - $a/t_i = 0.8$
G
Normalized ϕ angle

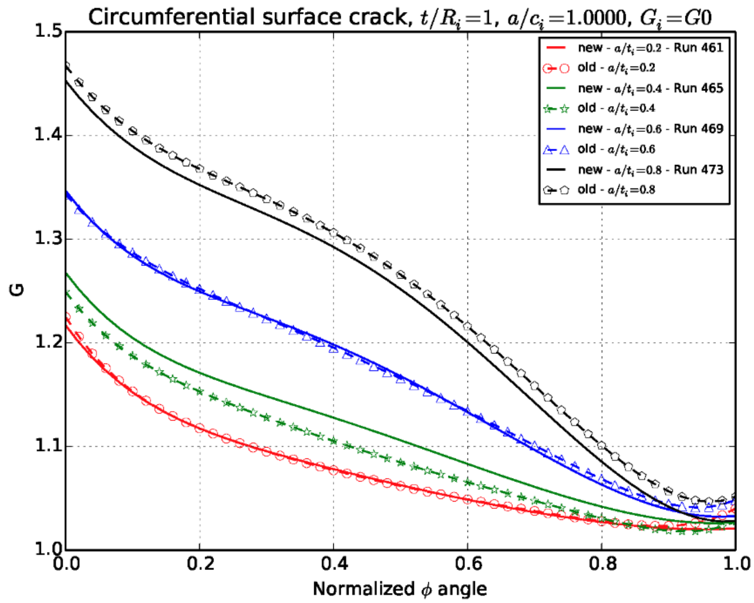

Circumferential surface crack, $t/R_i = 1$, $a/c_i = 0.2500$, $G_i = G6$
new - $a/t_i = 0.2$ - Run 432
old - $a/t_i = 0.2$
new - $a/t_i = 0.4$ - Run 436
old - $a/t_i = 0.4$
new - $a/t_i = 0.6$ - Run 440
old - $a/t_i = 0.6$
new - $a/t_i = 0.8$ - Run 444
old - $a/t_i = 0.8$
G
Normalized ϕ angle

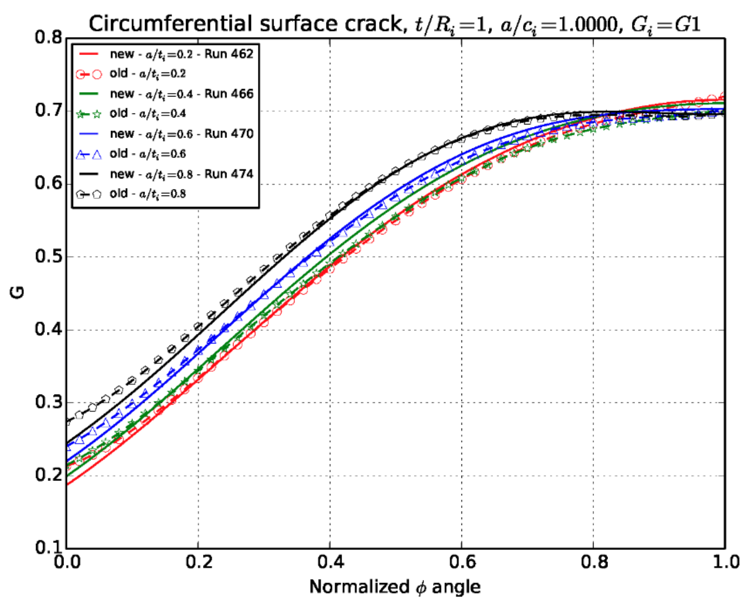

Circumferential surface crack, $t/R_i=1$, $a/c_i=0.5000$, $G_i=G0$
new - a/t_i=0.2 - Run 445
old - a/t_i=0.2
new - a/t_i=0.4 - Run 449
old - a/t_i=0.4
new - a/t_i=0.6 - Run 453
old - a/t_i=0.6
new - a/t_i=0.8 - Run 457
old - a/t_i=0.8
G
Normalized ϕ angle

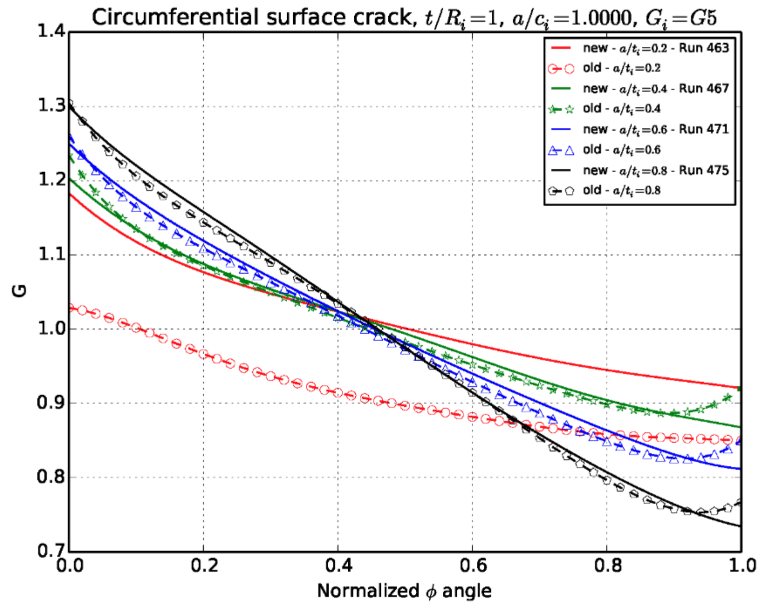

Circumferential surface crack, $t/R_i=1$, $a/c_i=0.5000$, $G_i=G1$
new - a/t_i=0.2 - Run 446
old - a/t_i=0.2
new - a/t_i=0.4 - Run 450
old - a/t_i=0.4
new - a/t_i=0.6 - Run 454
old - a/t_i=0.6
new - a/t_i=0.8 - Run 458
old - a/t_i=0.8
G
Normalized ϕ angle

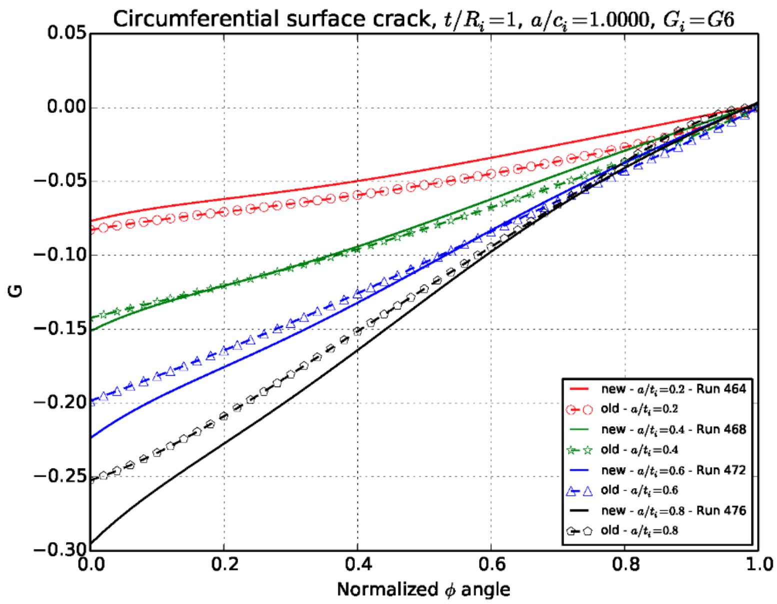

Circumferential surface crack, $t/R_i=1$, $a/c_i=0.5000$, $G_i=G5$
new - $a/t_i=0.2$ - Run 447
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 451
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 455
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 459
old - $a/t_i=0.8$
G
Normalized ϕ angle

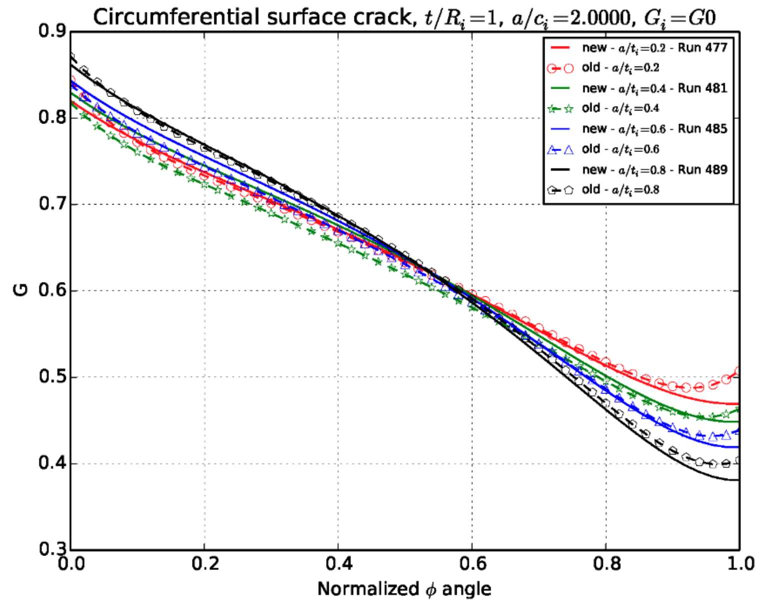

Circumferential surface crack, $t/R_i=1$, $a/c_i=0.5000$, $G_i=G6$
new - $a/t_i=0.2$ - Run 448
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 452
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 456
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 460
old - $a/t_i=0.8$
G
Normalized ϕ angle

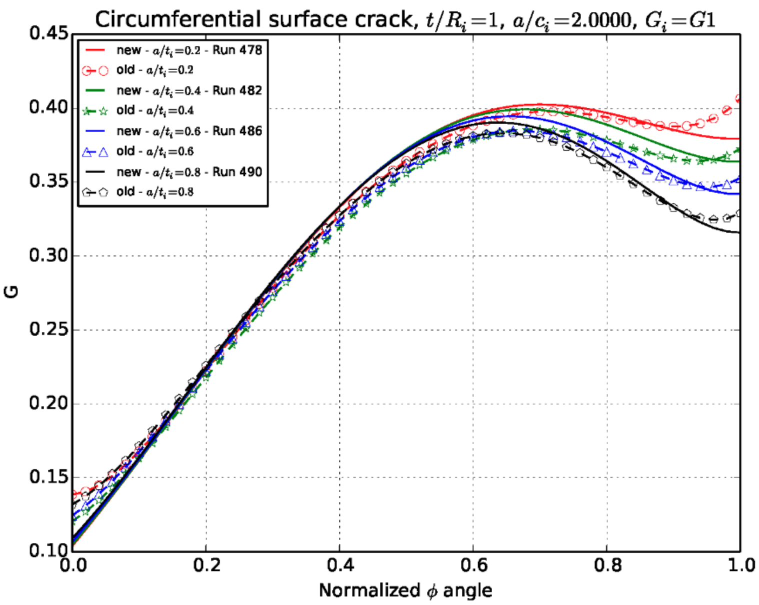

Circumferential surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G0$
new - a/t_i=0.2 - Run 461
old - a/t_i=0.2
new - a/t_i=0.4 - Run 465
old - a/t_i=0.4
new - a/t_i=0.6 - Run 469
old - a/t_i=0.6
new - a/t_i=0.8 - Run 473
old - a/t_i=0.8
G
Normalized ϕ angle

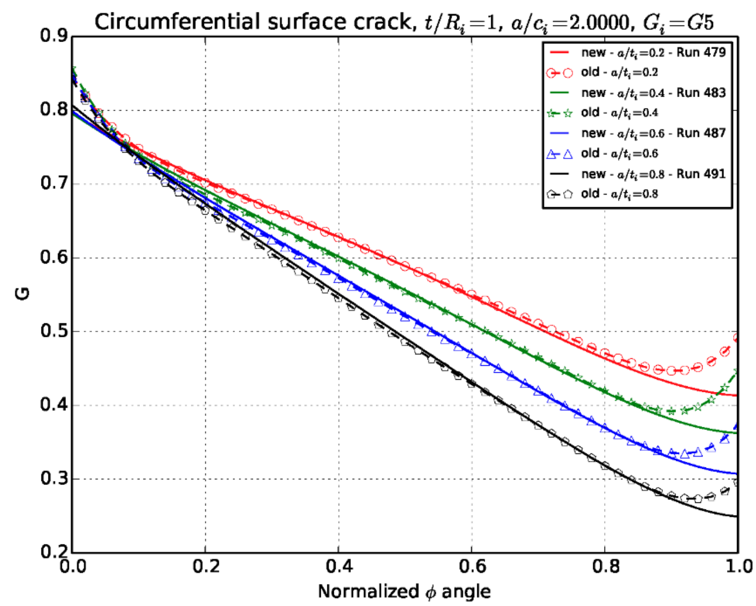

Circumferential surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G1$
new - a/t_i=0.2 - Run 462
old - a/t_i=0.2
new - a/t_i=0.4 - Run 466
old - a/t_i=0.4
new - a/t_i=0.6 - Run 470
old - a/t_i=0.6
new - a/t_i=0.8 - Run 474
old - a/t_i=0.8
G
Normalized ϕ angle

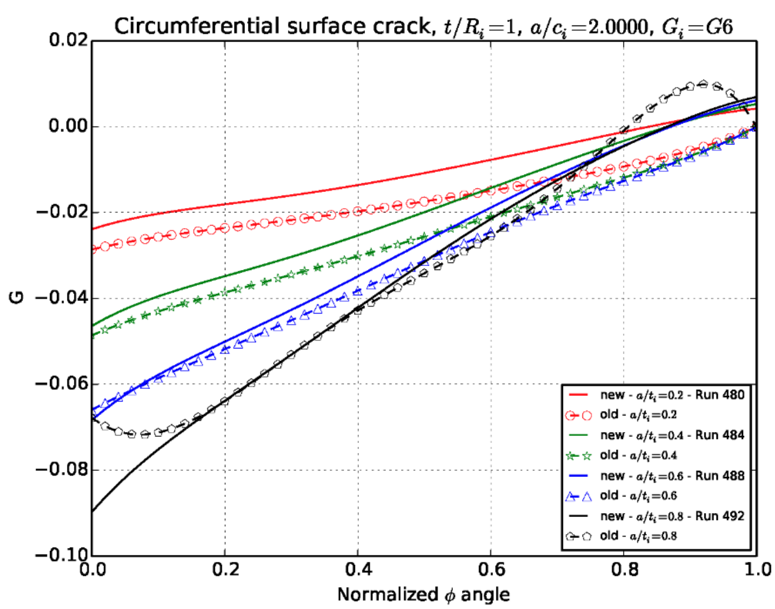

Circumferential surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G5$
new - $a/t_i=0.2$ - Run 463
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 467
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 471
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 475
old - $a/t_i=0.8$
G
Normalized ϕ angle


Circumferential surface crack, $t/R_i=1$, $a/c_i=1.0000$, $G_i=G6$
new - $a/t_i=0.2$ - Run 464
old - $a/t_i=0.2$
new - $a/t_i=0.4$ - Run 468
old - $a/t_i=0.4$
new - $a/t_i=0.6$ - Run 472
old - $a/t_i=0.6$
new - $a/t_i=0.8$ - Run 476
old - $a/t_i=0.8$
G
Normalized ϕ angle


Circumferential surface crack, $t/R_i = 1$, $a/c_i = 2.0000$, $G_i = G0$
new - $a/t_i = 0.2$ - Run 477
old - $a/t_i = 0.2$
new - $a/t_i = 0.4$ - Run 481
old - $a/t_i = 0.4$
new - $a/t_i = 0.6$ - Run 485
old - $a/t_i = 0.6$
new - $a/t_i = 0.8$ - Run 489
old - $a/t_i = 0.8$
G
Normalized ϕ angle
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.0
0.2
0.4
0.6
0.8
1.0

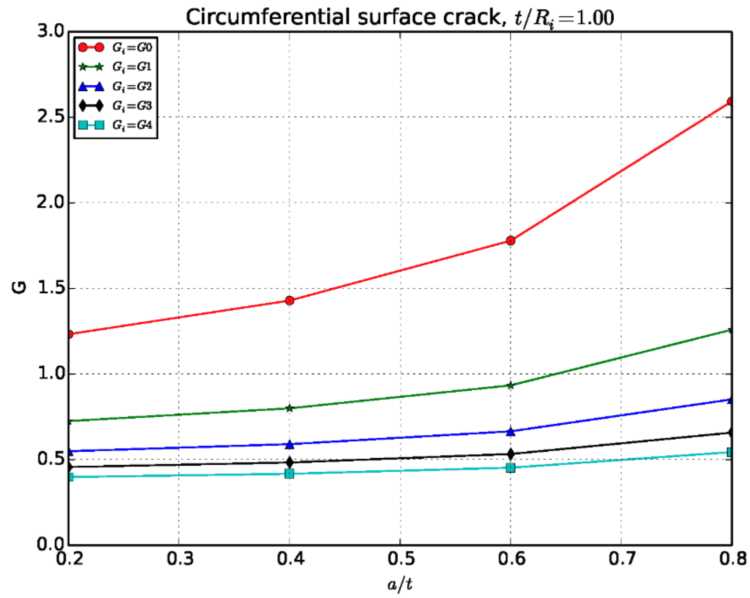

Circumferential surface crack, $t/R_i = 1$, $a/c_i = 2.0000$, $G_i = G1$
new - $a/t_i = 0.2$ - Run 478
old - $a/t_i = 0.2$
new - $a/t_i = 0.4$ - Run 482
old - $a/t_i = 0.4$
new - $a/t_i = 0.6$ - Run 486
old - $a/t_i = 0.6$
new - $a/t_i = 0.8$ - Run 490
old - $a/t_i = 0.8$
G
Normalized ϕ angle
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.0
0.2
0.4
0.6
0.8
1.0

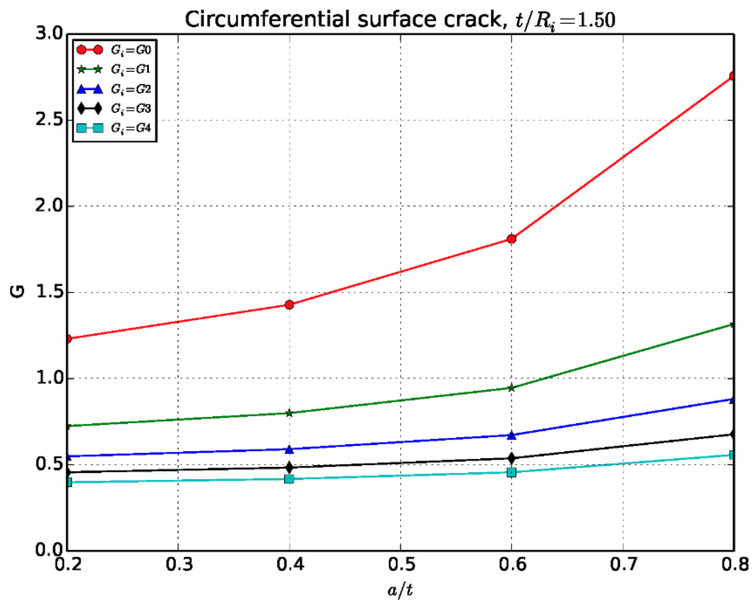

Circumferential surface crack, $t/R_i=1$, $a/c_i=2.0000$, $G_i=G5$
new - a/t_i=0.2 - Run 479
old - a/t_i=0.2
new - a/t_i=0.4 - Run 483
old - a/t_i=0.4
new - a/t_i=0.6 - Run 487
old - a/t_i=0.6
new - a/t_i=0.8 - Run 491
old - a/t_i=0.8
G
Normalized ϕ angle

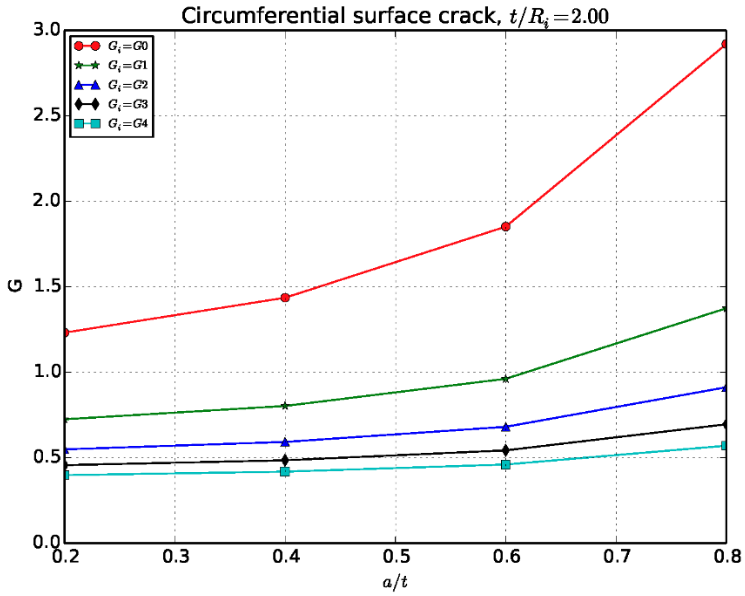

Circumferential surface crack, $t/R_i=1$, $a/c_i=2.0000$, $G_i=G6$
new - a/t_i=0.2 - Run 480
old - a/t_i=0.2
new - a/t_i=0.4 - Run 484
old - a/t_i=0.4
new - a/t_i=0.6 - Run 488
old - a/t_i=0.6
new - a/t_i=0.8 - Run 492
old - a/t_i=0.8
G
Normalized ϕ angle

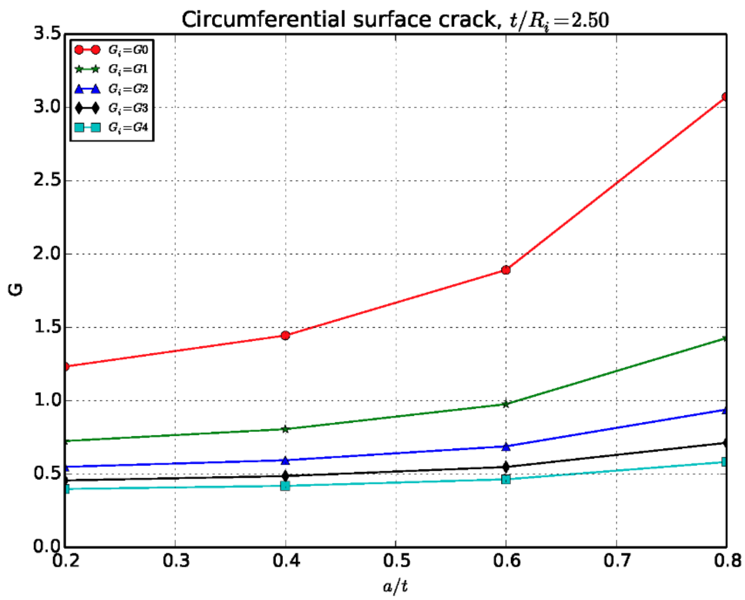
APPENDIX M: CIRCUMFERENTIAL EXTERNAL 360° CRACK G RESULTS PLOTS

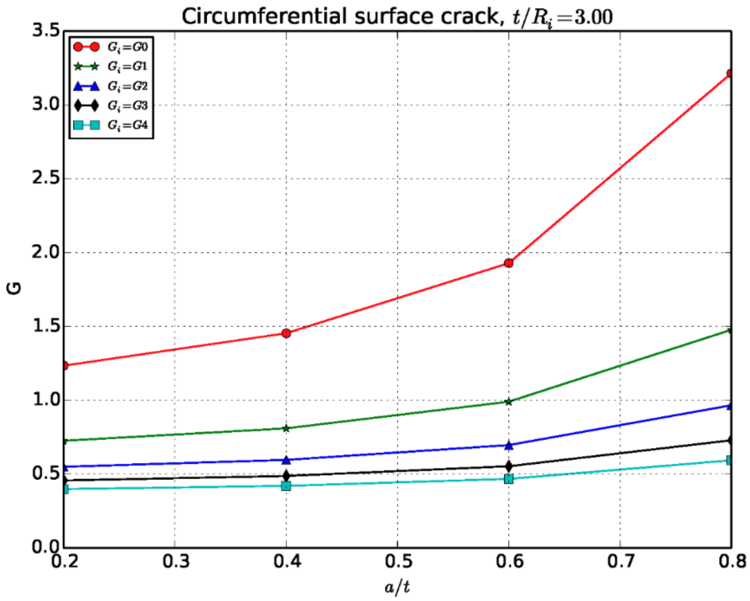
Plots showing all of the circumferential 360º crack cases; plot G versus the a/t ratio. There are five curves per plot to show the uniform G0 to quartic G4 load cases. Each page contains the plots for a particular t/Ri ratio; 5 plots total.





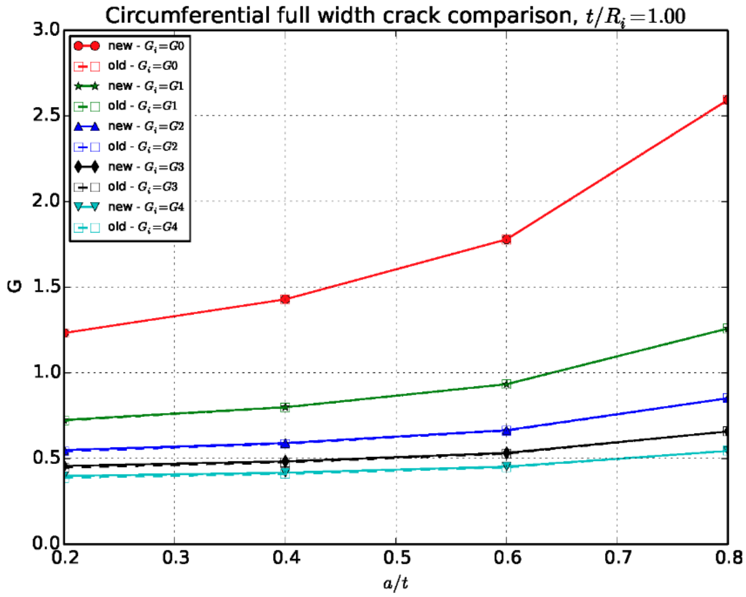

Circumferential surface crack, $t/R_i = 2.00$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Circumferential surface crack, $t/R_i = 2.50$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Circumferential surface crack, $t/R_i = 3.00$
$G_i = G0$
$G_i = G1$
$G_i = G2$
$G_i = G3$
$G_i = G4$
G
a/t
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0.2
0.3
0.4
0.5
0.6
0.7
0.8

APPENDIX N: CIRCUMFERENTIAL EXTERNAL 360° CRACK COMPARISON TO PREVIOUS RESULTS

Plots to compare G results for the t/Ri=1 ratio from the previous results to the new results. Plot curves with open data points and dashed lines show the previous results, and plot curves with filled data points and solid lines show the new results. There is one plot of G versus a/t ratio, four data points for each load case. The previous results were obtained from API 579, Annex C, Table C.11 [1].



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