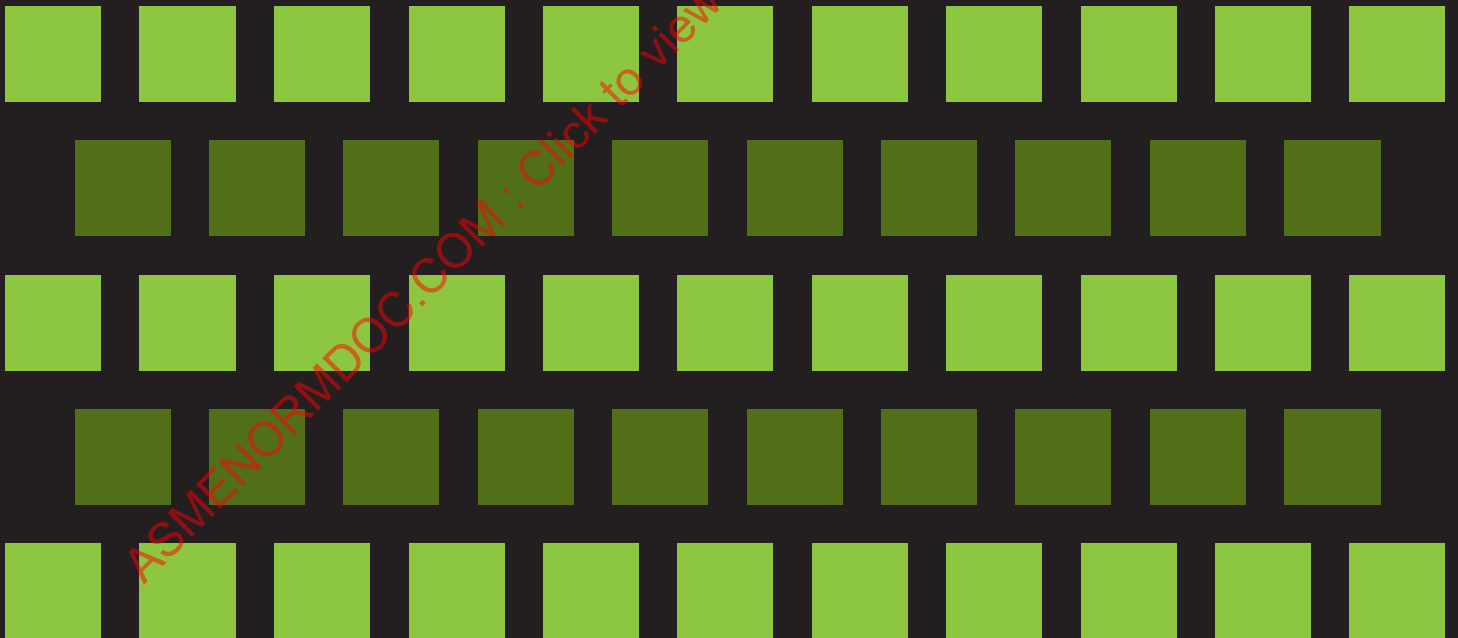


STRESS INTENSITY FACTOR SOLUTIONS FOR INTERNAL CRACKS IN THICK-WALLED CYLINDER VESSELS



STP-PT-071

STRESS INTENSITY FACTOR SOLUTIONS FOR INTERNAL CRACKS IN THICK-WALLED CYLINDER VESSELS

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FOREWORD

Stress intensity K factors were computed for internal cracks in thick-walled cylinders. The 744 cases include a range of geometry ratios and crack size ratios for internal axial and internal circumferential surface cracks, axial internal full-width partial depth axial cracks, and circumferential internal 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 FEA 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.

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.

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EXECUTIVE SUMMARY

This report describes the analysis methods and results for internal surface crack stress intensity K solutions in thick-walled cylinders. The 744 cases include a range of geometry ratios and crack size ratios for internal axial and internal 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.

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1 INTRODUCTION

This report computes the stress intensity K factors for internal surface cracks in thick-walled cylinder vessels. The 744 crack analysis cases for this project extend the K factor solutions available in the API 579-1/ASME FFS-1 Annex C tables [1].

The analysis method uses the FEACrack™ [2] software to generate the three-dimensional (3D) crack meshes, described below. The FEACrack software, a commercial product for 3D crack mesh generation and analysis, was originally released in 1998, and was used to create most of the K 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 (FEA) 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 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/R_i and a/c ratios used in the API 579 Annex C tables, where R_i is the cylinder inside radius and c is the half semi-elliptical surface crack length: $t/R_i = Y - 1$, $a/l = (a/c)/2$, $2c = l$. 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 Figure 1-1 through Figure 1-3 below. The $Y = 2$ ratio ($t/R_i = 1$) 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 ($t/R_i = 3$) 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.

Figure 1-1: Y and t/R_i Ratios to Set the Cylinder Thickness, t

case	$Y=OD/ID$	t/R_i
1	2	1
2	2.5	1.5
3	3	2
4	3.5	2.5
5	4	3

Figure 1-2: a/l and a/c Ratios to Set the Crack Length, $l=2c$

case	$a/l=a/2c$	a/c
1	0.015625	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	

Figure 1-3: 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 inside circumference, so those cases are omitted. Figure 1-4 summarizes the valid circumferential surface crack cases, including the 360-degree crack cases that provide a bounding case for the circumferential crack solutions.

Figure 1-4: Internal Circumferential Crack Valid Cases

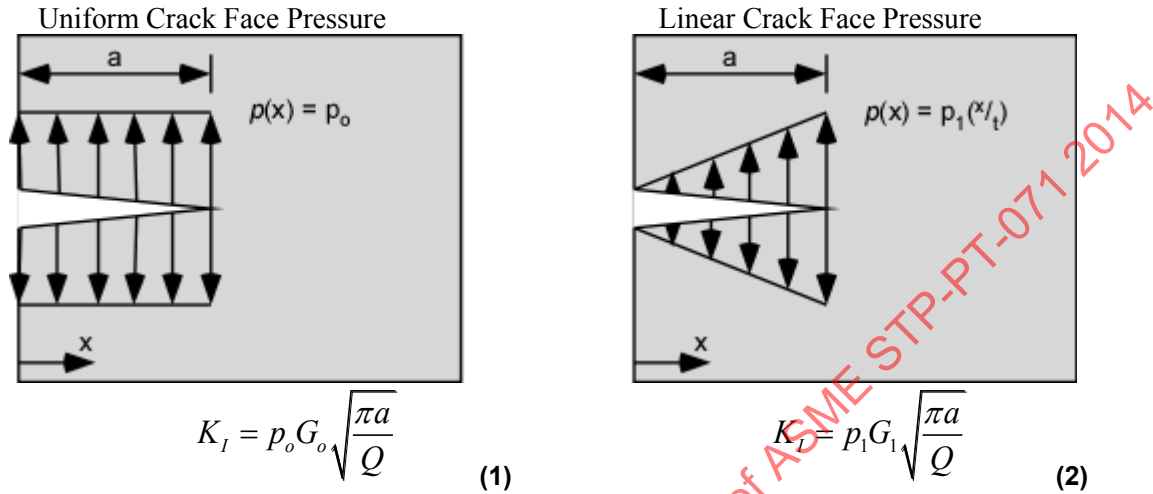
Y=OD/ID =	2							
	a/l=a/2c							
a/t	360-deg	0.015625	0.03125	0.0625	0.125	0.25	0.5	1
0.2	ok	too long	too long	ok	ok	ok	ok	ok
0.4	ok	too long	too long	too long	ok	ok	ok	ok
0.6	ok	too long	too long	too long	ok	ok	ok	ok
0.8	ok	too long	too long	too long	too long	ok	ok	ok
Y=OD/ID =	2.5							
	a/l=a/2c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

1.2 Geometry Factors

The stress intensity K factors are given in the API 579 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° 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° 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 1-5, 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 1-5: Crack Face Pressure Distributions



The circumferential surface cracks also have two global bending K solutions in API 579 Table C.14 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 FEA 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.

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: $K_{\text{total}} = K_{\text{bending}} + K_{\text{axial}}$. The bending only stress intensity is obtained by subtracting the axial load case from the combined load case: $K_{\text{bending}} = K_{\text{total}} - K_{\text{axial}}$. 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 uses the crack front stress intensity K values from the Abaqus results file and 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 Annex C tables. The geometry factor polynomial, G , is given by the equations below [API 579 eq. 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: $G(\beta=1) = \sum A_i, i=0,6$. 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 Section C.14 [3]. 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 obtained using the weight function method.

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2 AXIAL INTERNAL SURFACE CRACKS

The combination of geometry ratios and two load cases gives 280 axial internal surface crack meshes. The model “Run ID” numbers are used to uniquely identify each case, and are from 1 through 280. The non-dimensional G polynomial coefficient results are listed in Table 1 in Appendix A.

The axial internal 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, $Y = 4$ ($t/R_i = 3$) is shown in Figure 2-3.

Figure 2-1: Quarter Symmetric Crack Mesh, Case 149, $t/R_i=2$, $a/c=0.5$, $a/t=0.6$

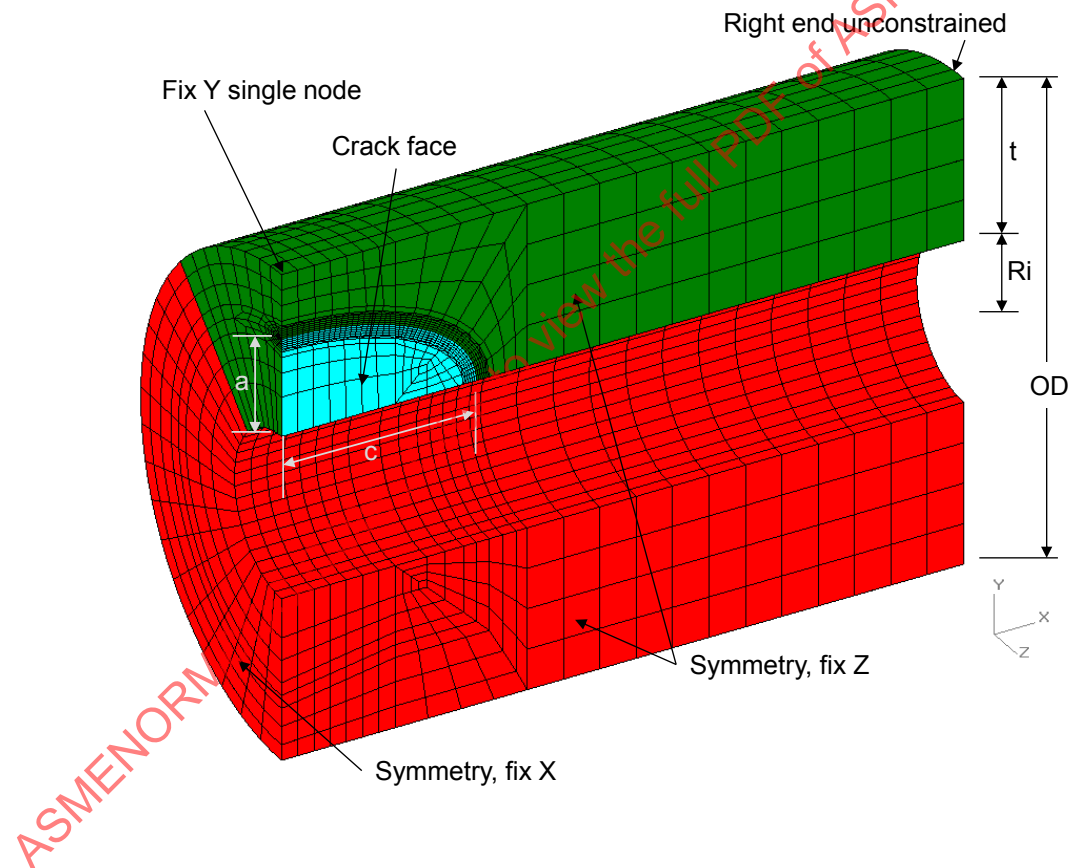


Figure 2-2: Shallow Crack Mesh Example, Case 17, $t/R_i=1$, $a/c=0.125$, $a/t=0.2$

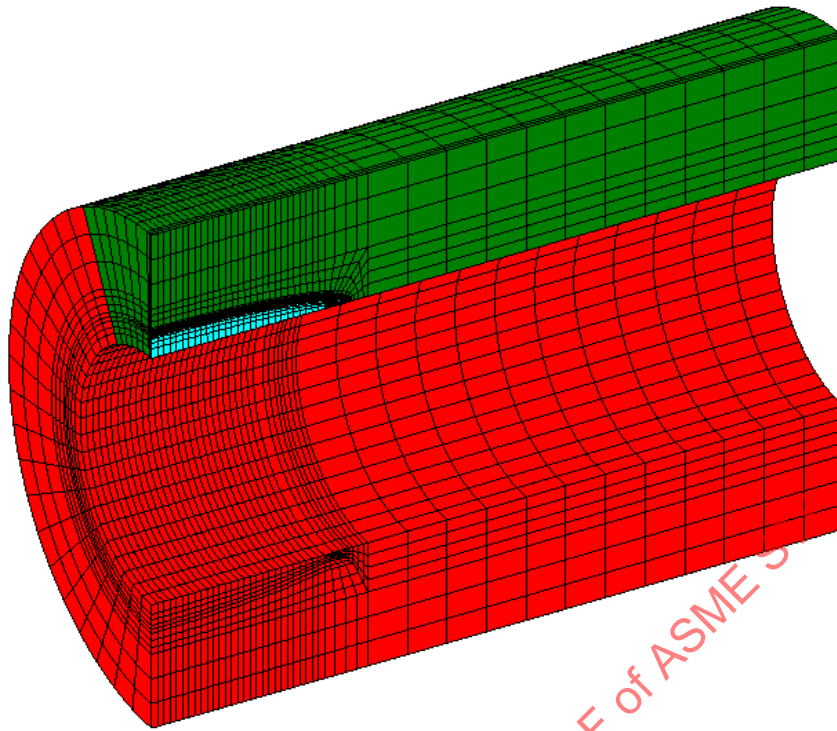
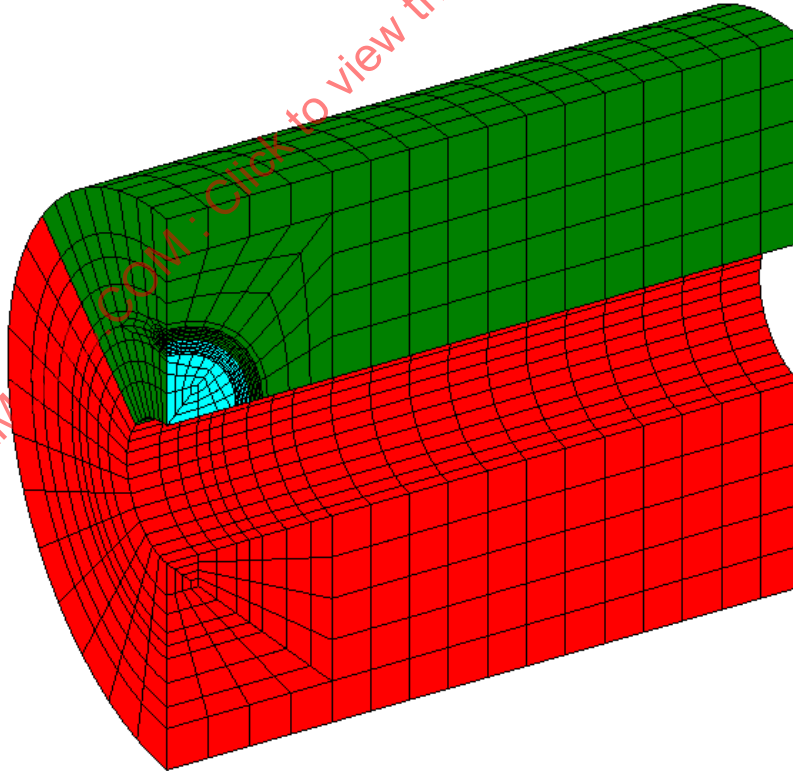


Figure 2-3: Thickest Cylinder Example, Case 267, $t/R_i=3$, $a/c=1.0$, $a/t=0.4$

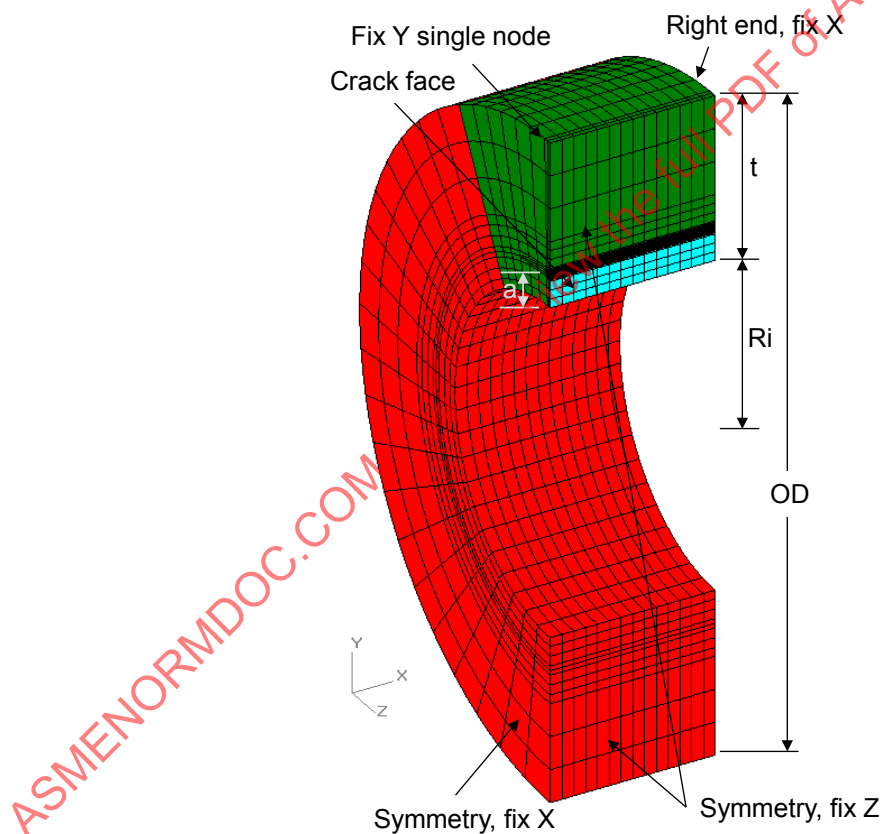


3 AXIAL INTERNAL FULL-WIDTH CRACKS

The combination of geometry ratios and five load cases gives 100 axial internal 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, and are from 301 through 400. The non-dimensional G polynomial coefficient results are listed in Table 2 in Appendix B.

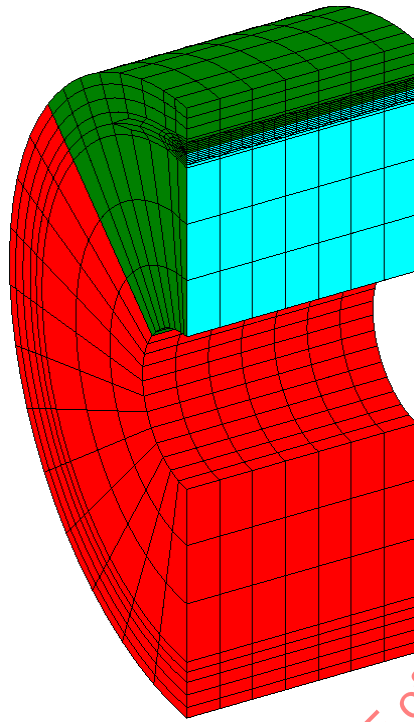
The axial full-width crack meshes are quarter symmetric models; the constraints and dimensions are shown in Figure 3-1. The left end of the cylinder is the cross-section symmetry plane and has an X-constraint. The top and bottom mesh surfaces are on the axial symmetry plane and have a Z-constraint outside 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.

Figure 3-1: Internal Full-Width Crack, Case 301, $t/R_i=1$, $a/t=0.2$



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

Figure 3-2: Thickest Cylinder, Full-Width Crack, Case 396, $t/R_i=3$, $a/t=0.8$



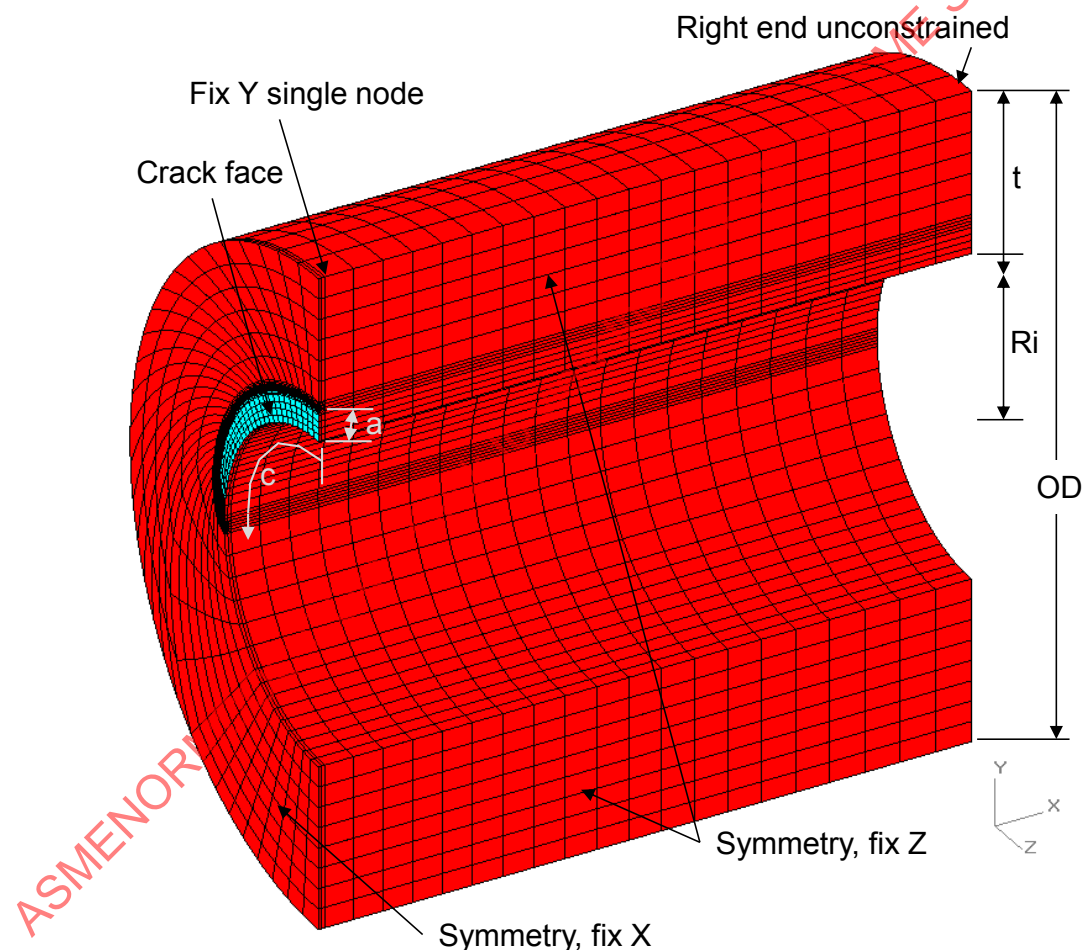
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4 CIRCUMFERENTIAL INTERNAL SURFACE CRACKS

The combination of geometry ratios and four load cases gives 264 internal circumferential surface crack meshes. The model “Run ID” numbers are used to uniquely identify each case and are from 501 through 1060, with gaps for cases where the crack length is too long for the inside cylinder circumference (see Figure 1-4). The non-dimensional G polynomial coefficient results are listed in Table 3 in Appendix C.

The circumferential surface crack meshes are quarter symmetric models for the crack face pressure and in-plane bending load cases. Half symmetric models are needed for the out-of-plane bending load case. 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: Internal Circumferential Surface Crack, Case 533, $t/R_i=1$, $a/c=0.125$, $a/t=0.2$



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 out-of-plane bending load case 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 797, $t/R_i=2$, $a/c=0.5$, $a/t=0.6$

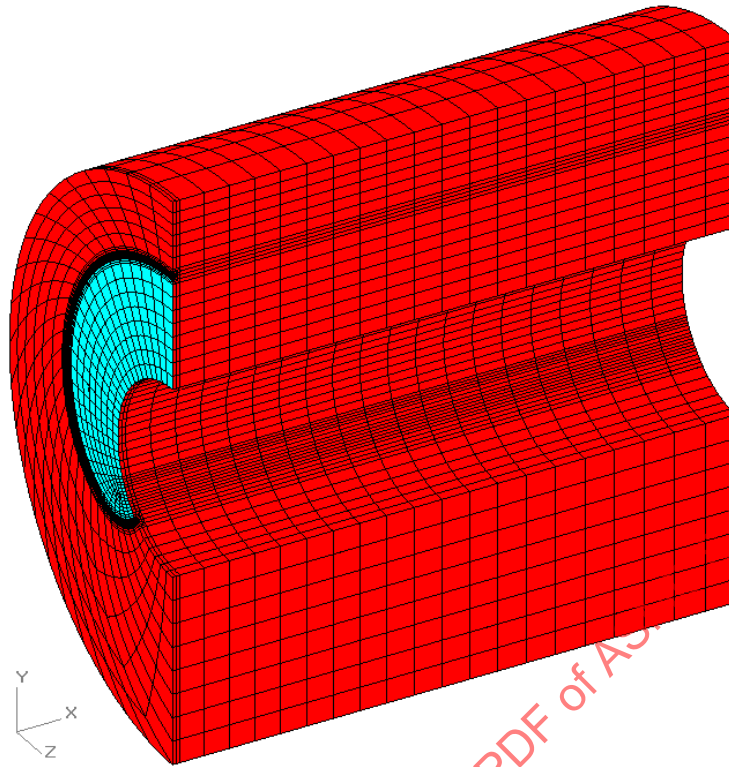


Figure 4-3: Circumferential Surface Crack Case 1033, $t/R_i=3$, $a/c=1.0$, $a/t=0.4$, Thickest Cylinder

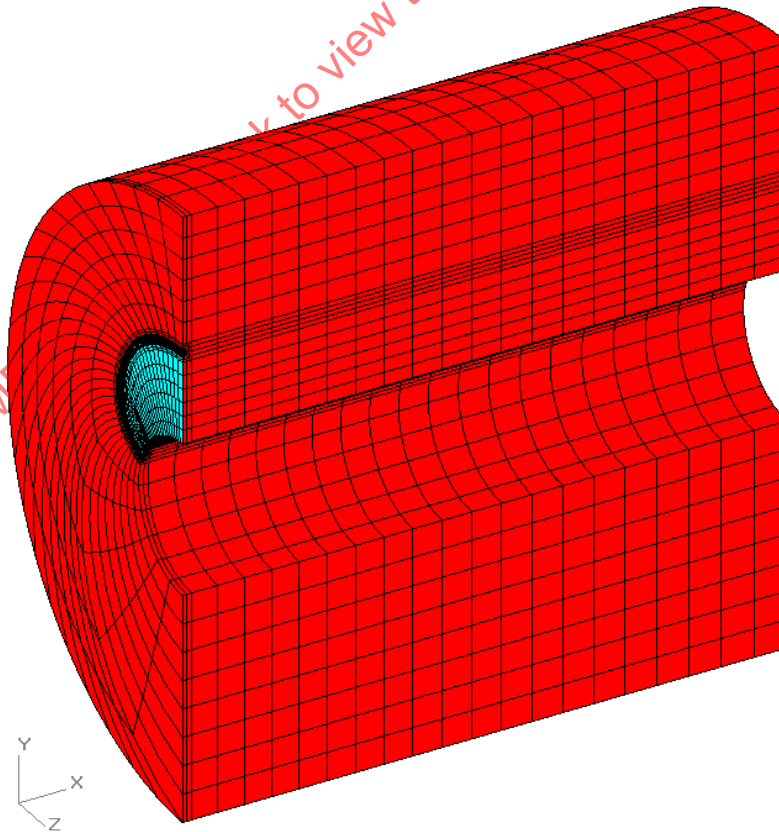


Figure 4-4: Case 1036, $t/R_i=3$, $a/c=1.0$, $a/t=0.4$, Half Symmetric Mesh to Apply the Out-of-Plane Bending Load about the Y-Axis

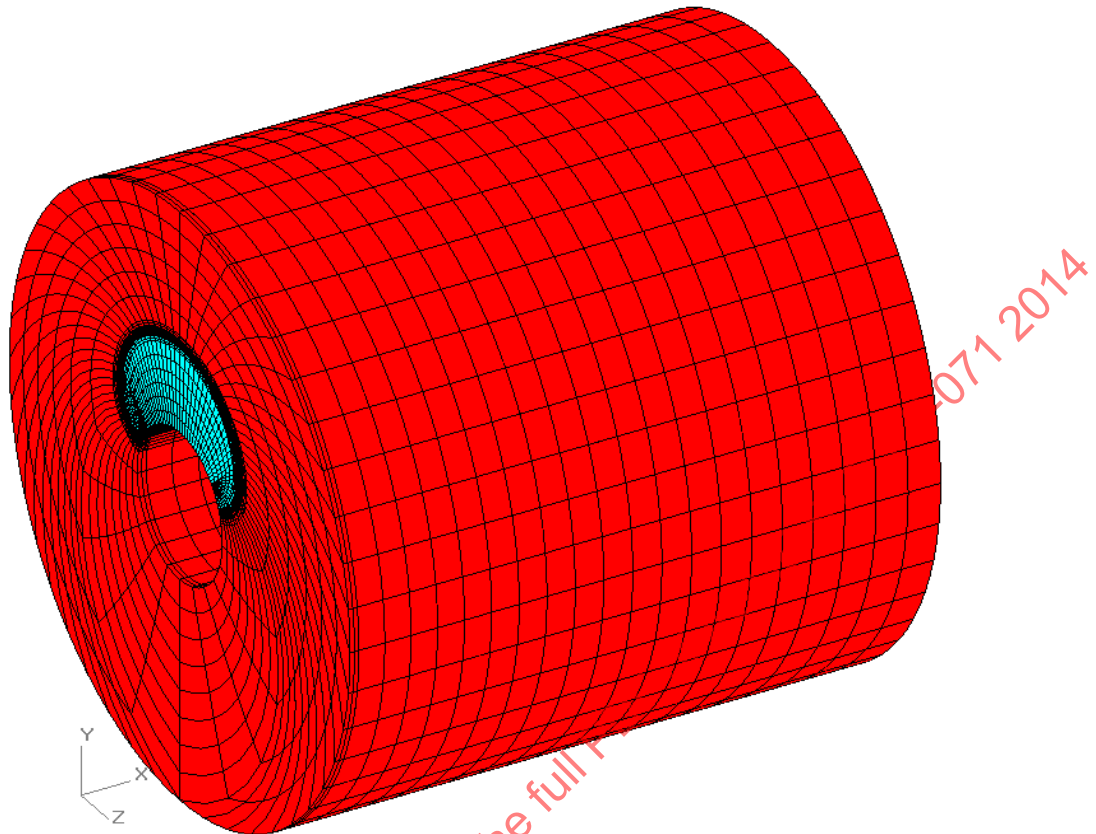


Figure 4-5: Combined In-Plane Bending Plus Axial Load, Case 559, $t/R_i=1$, $a/c=0.25$, $a/t=0.6$

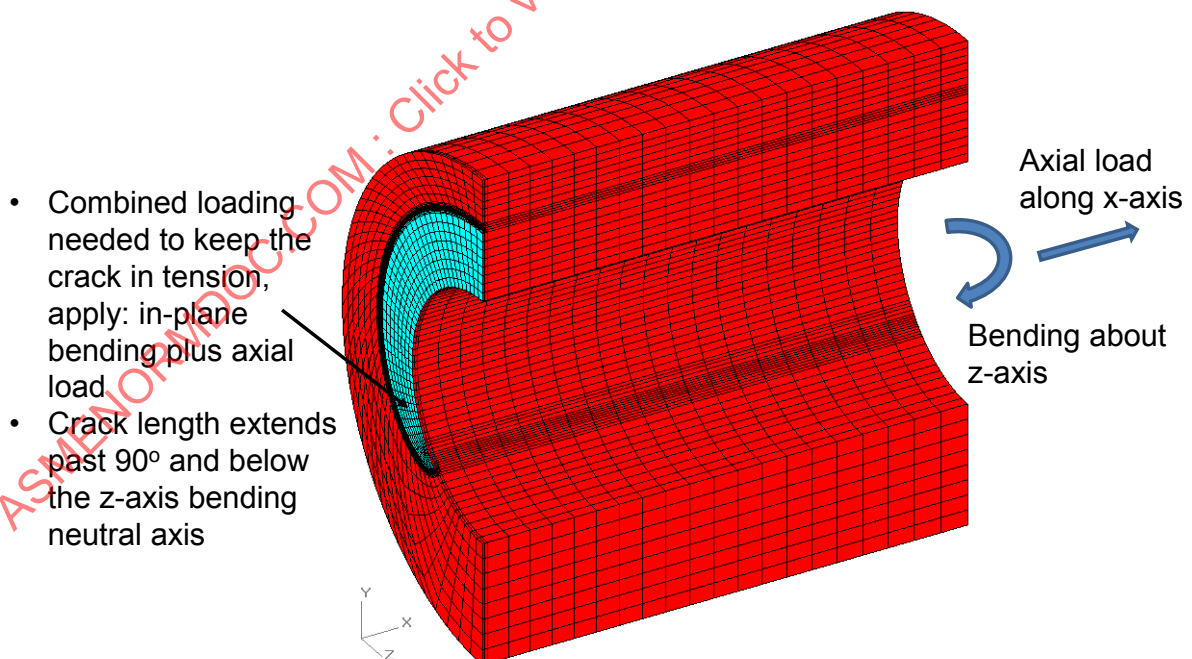
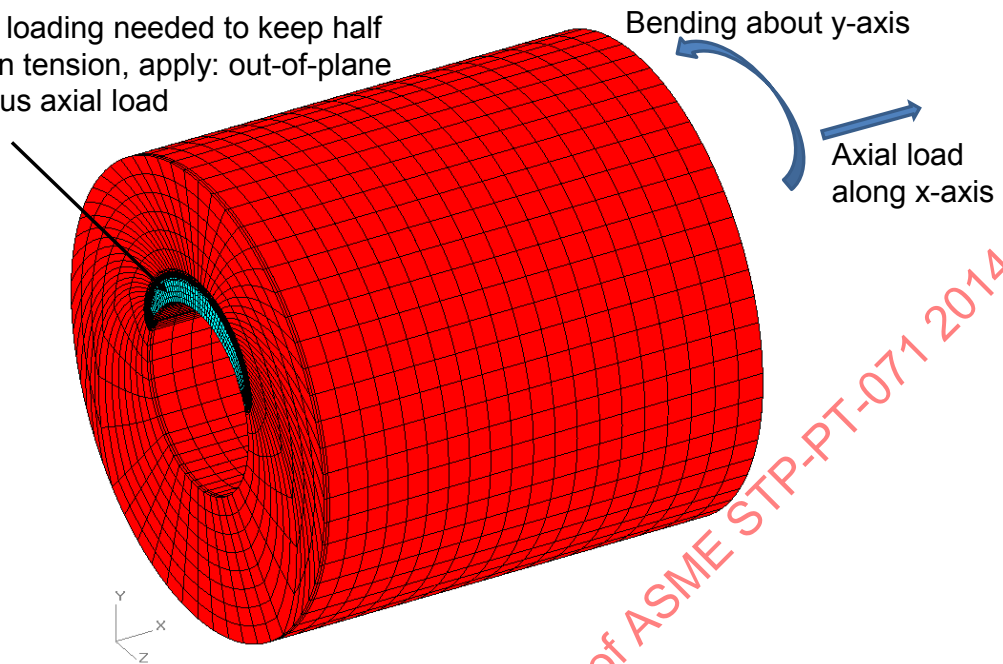


Figure 4-6: Combined Out-of-Plane Bending Plus Axial Load, Case 664, $t/R_i=1.5$, $a/c=0.25$, $a/t=0.2$

- Combined loading needed to keep half the crack in tension, apply: out-of-plane bending plus axial load



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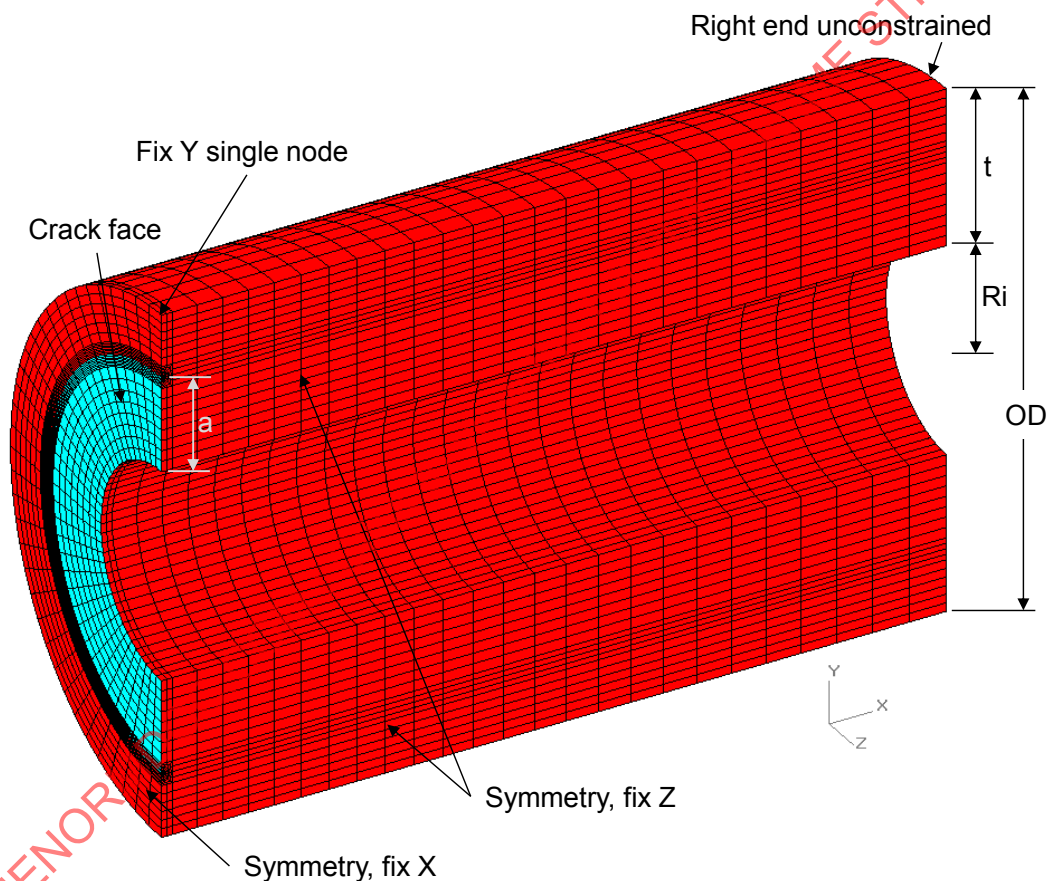
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5 CIRCUMFERENTIAL INTERNAL 360° CRACKS

The combination of geometry ratios and five load cases gives 100 circumferential internal 360° crack meshes. The 360° crack meshes are intended to provide a bounding solution for the crack lengths that are longer than the internal cylinder circumference. The model “Run ID” numbers are used to uniquely identify each case, and are from 1101 through 1200. The non-dimensional G polynomial coefficient results are listed in Table 4 in Appendix D.

The circumferential internal 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.

Figure 5-1: Internal Circumferential 360° Crack, Case 1131, $t/R_i=1.5$, $a/t=0.6$



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 5-2: 360° Crack, Case 1101, $t/R_i=1$, $a/t=0.2$, Shallow Crack Example

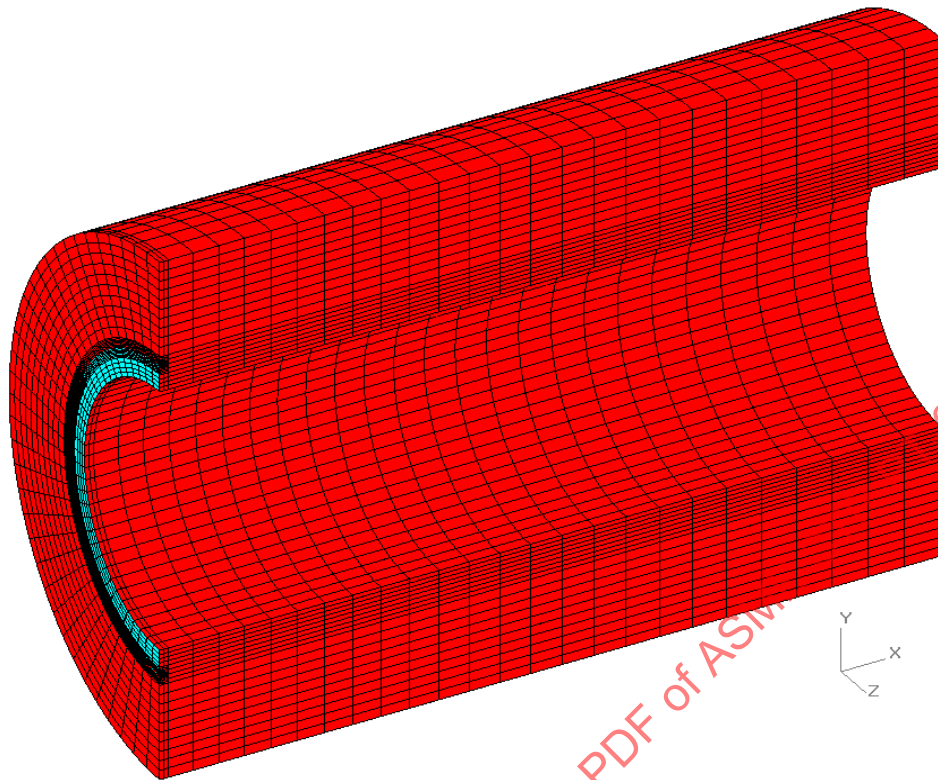
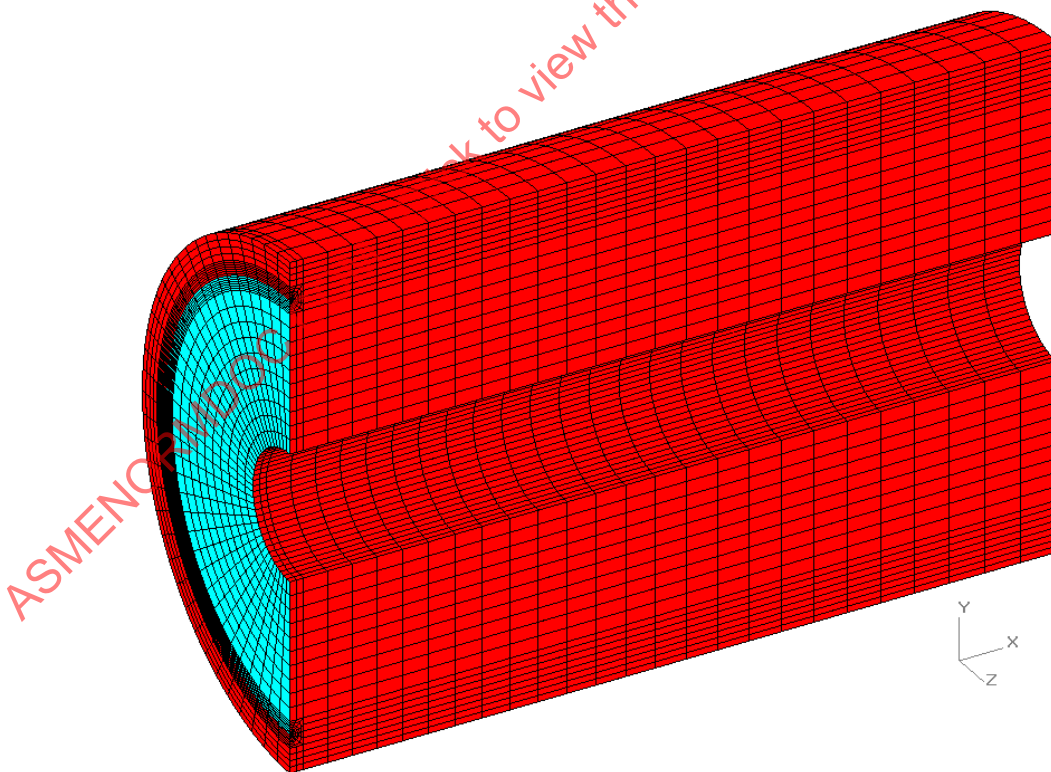


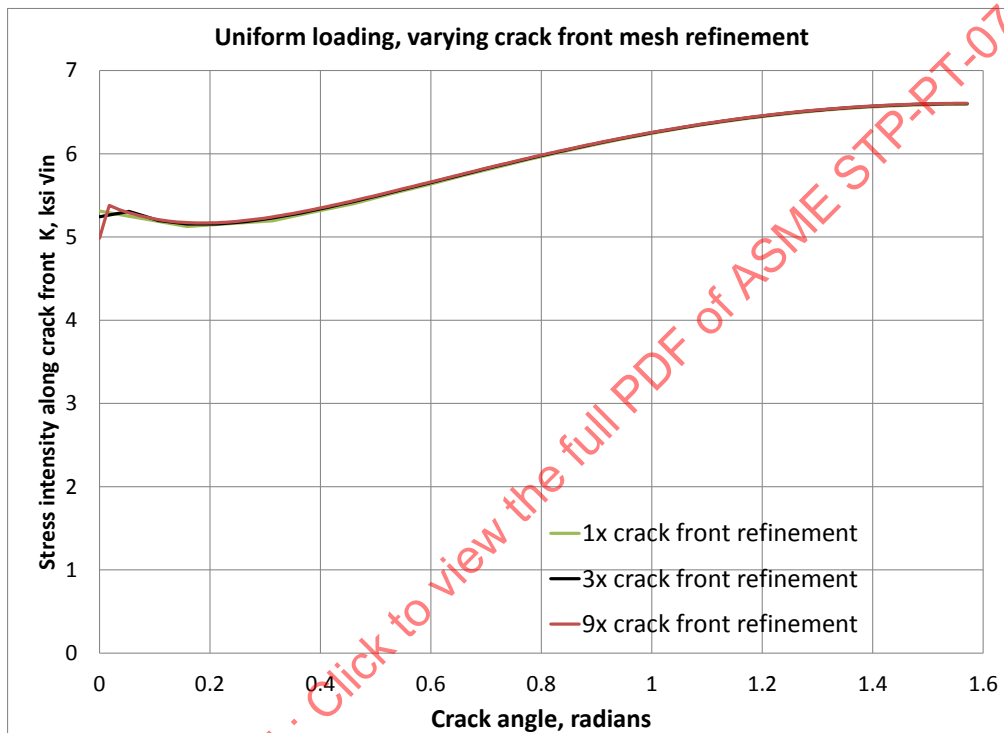
Figure 5-3: 360° Crack, Case 1196, $t/R_i=3$, $a/t=0.8$, Thickest Cylinder



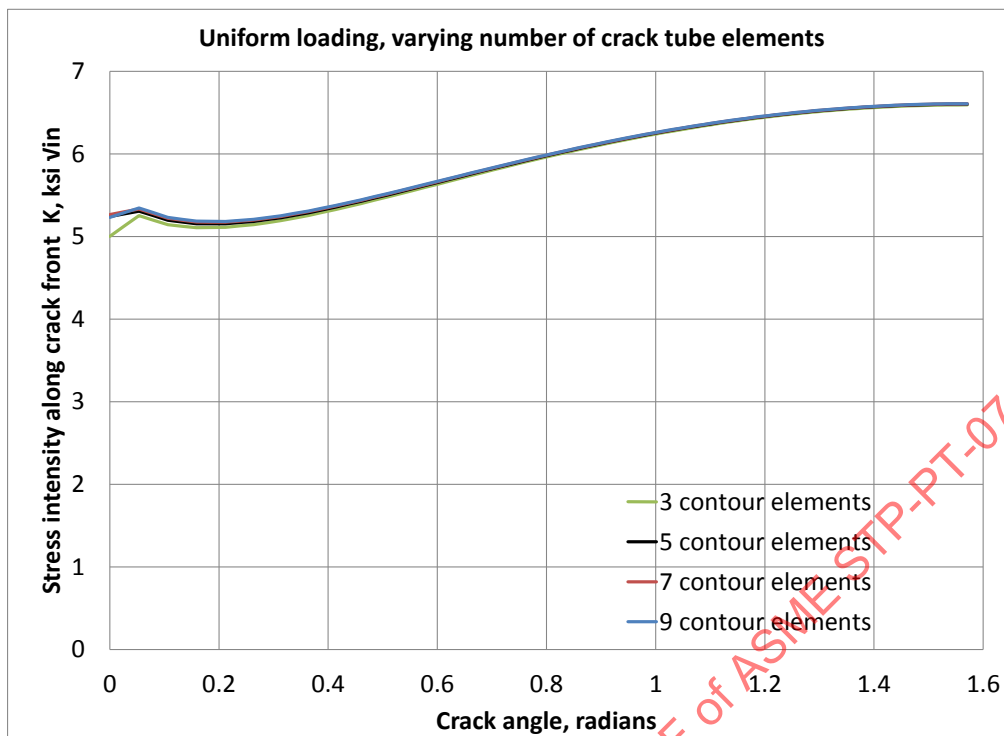
6 MESH REFINEMENT STUDY

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 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

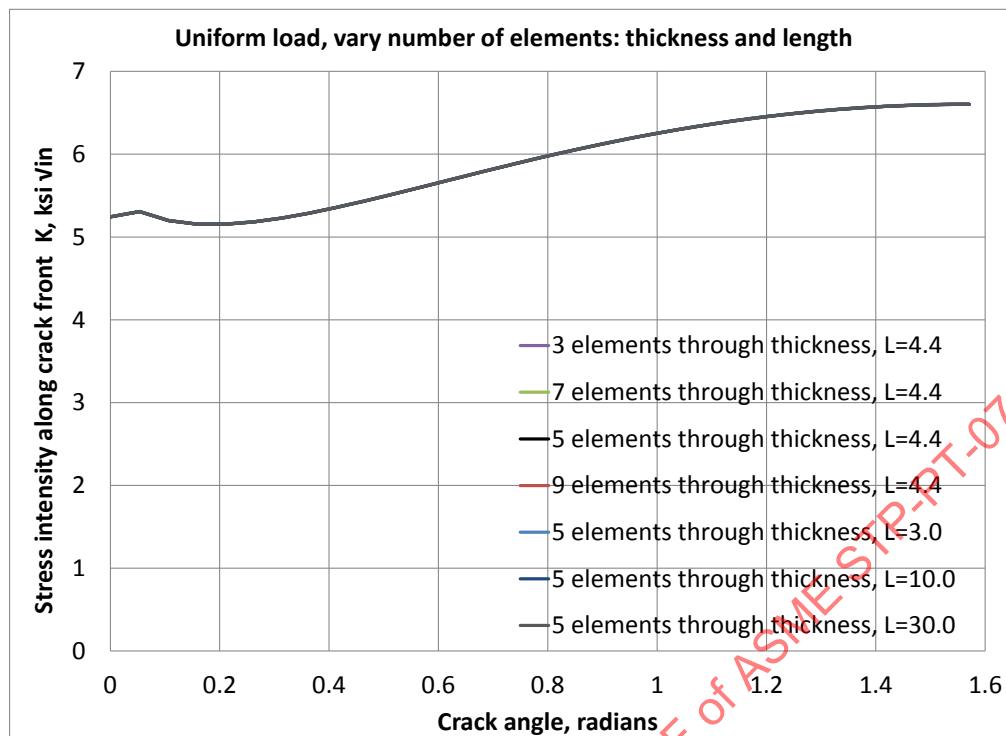


The number of elements in the contours around the crack front was varied from three to nine. The number of mesh contours sets the number of J-integral contours used to compute J and subsequently K along the crack front. The plot in Figure 6-2 shows overall good agreement, except near the crack tip for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

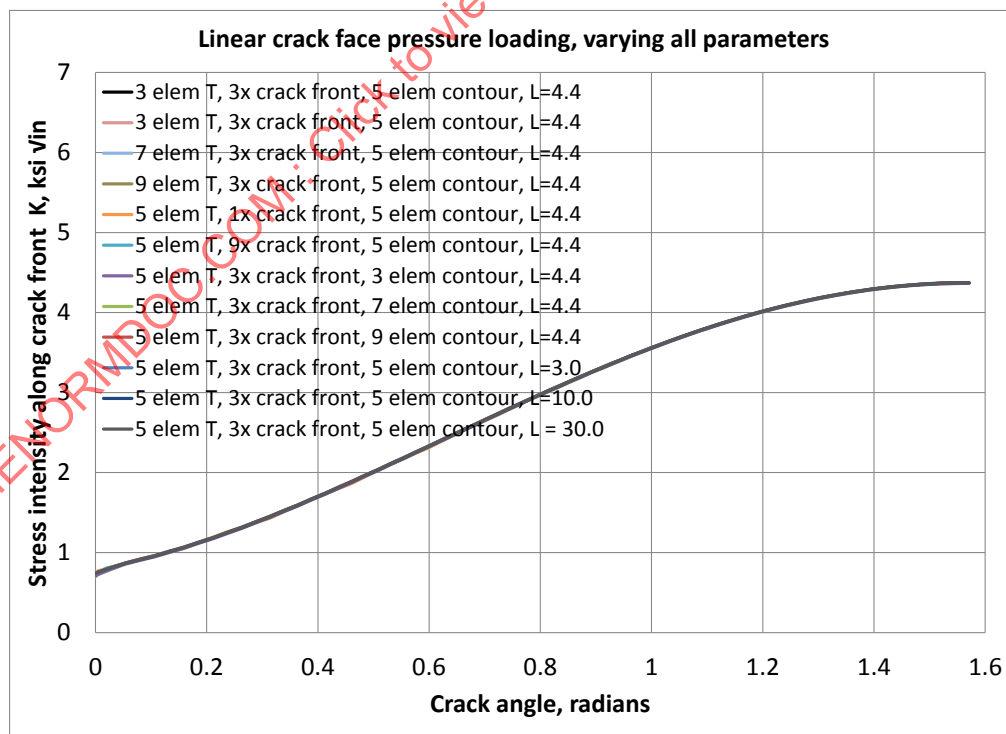
Figure 6-2: Compare the Number of Contours around the Crack Front

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 three 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 $2 \times OD$.

Figure 6-3: Compare the Number of Elements through the Thickness and the Cylinder Length

A combination of mesh refinement settings were used to compare the K results for the linear crack face pressure load case. No difference in the K results was observed from the plot in Figure 6-4, indicating that sufficient mesh refinement is available to compute accurate crack front J values.

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

The longest axial crack length was also used to compare the crack front refinement for case 175, $t/R_i=2.5$, $a/c=0.03125$, $a/t=0.8$. The analysis mesh has 285,865 nodes with 1,099 crack front nodes. The coarser comparison mesh has 135,146 nodes with 201 crack front nodes, and does not include the

3-to-1 crack front mesh transition option. The plot in Figure 6-5 shows good agreement in the K results along the crack front, indicating that the more refined crack mesh is sufficient for the analysis. Figure 6-6 shows the coarser comparison axial crack mesh picture.

Figure 6-5: Longest Axial Crack Mesh Comparison

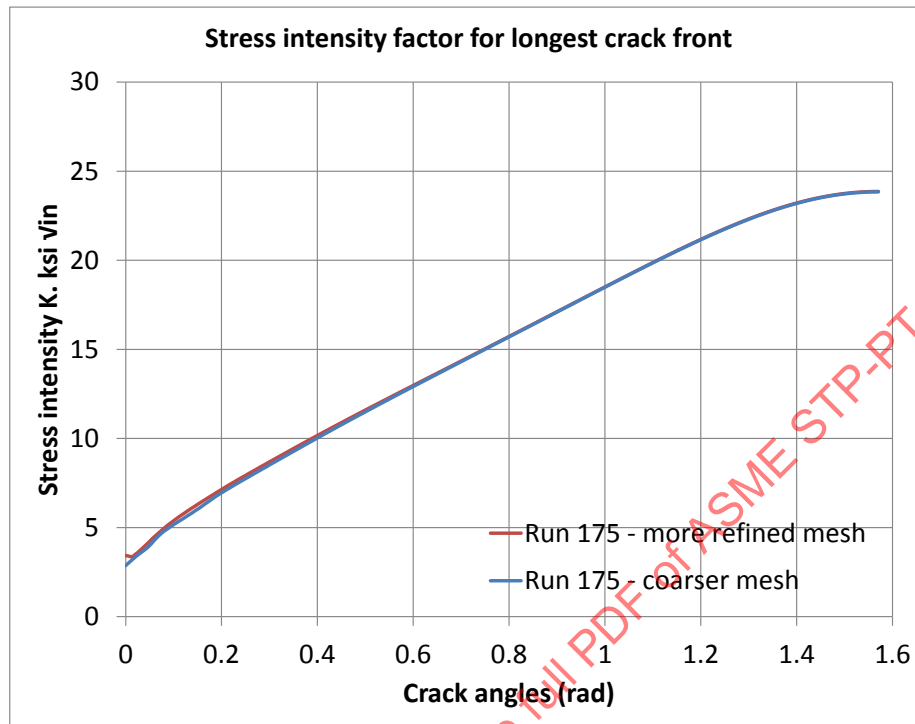
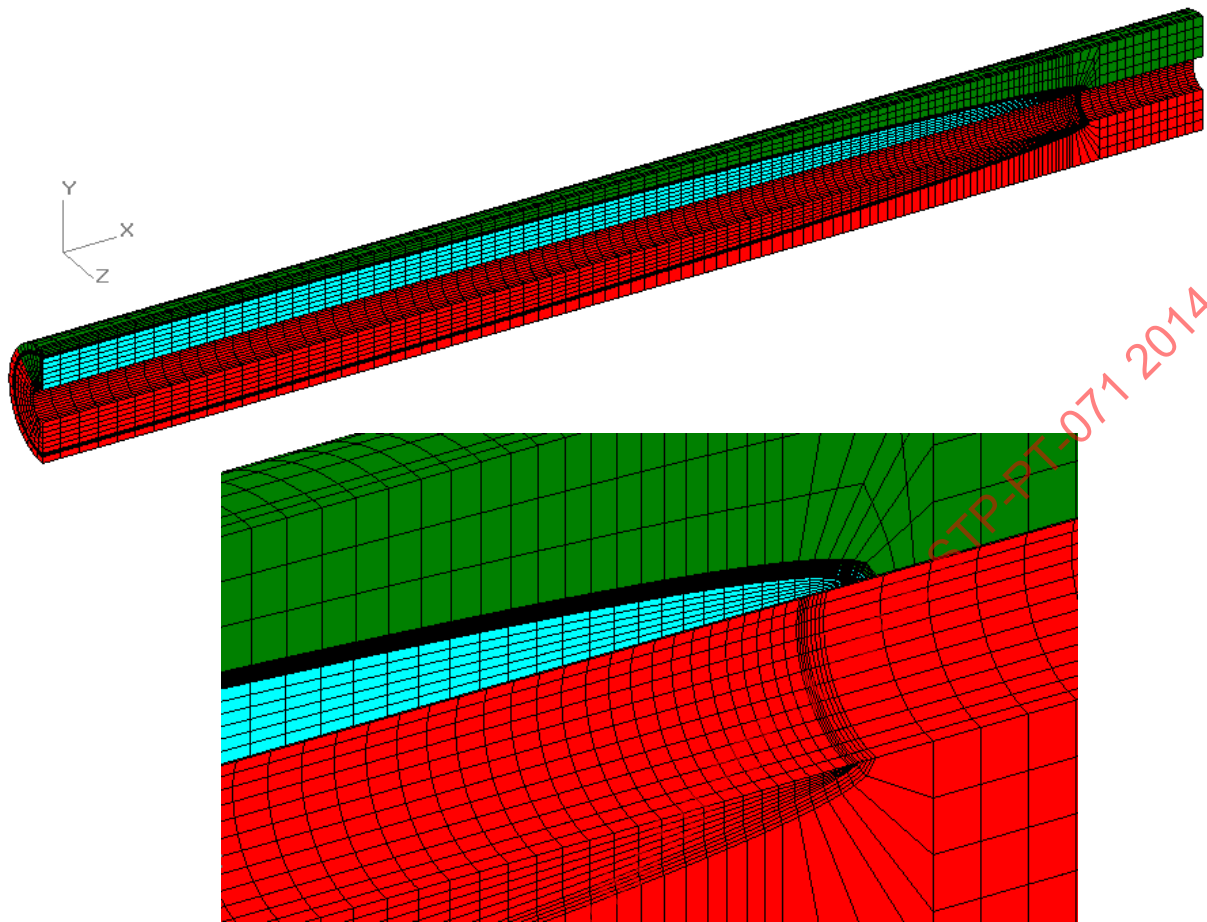


Figure 6-6: Comparison Coarser Mesh for the Longest Axial Internal Crack, Case 175



The mesh refinement results indicate that sufficient crack and cylinder mesh refinement was used in this analysis to obtain accurate crack front J-integral and stress intensity K results.

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 internal 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 $\phi=0$) 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 internal 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 internal circumferential surface crack results plots are shown in Figure 7-2 (crack face pressure loads) and Figure 7-3 (bending loads) for cases 565 to 580.

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

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

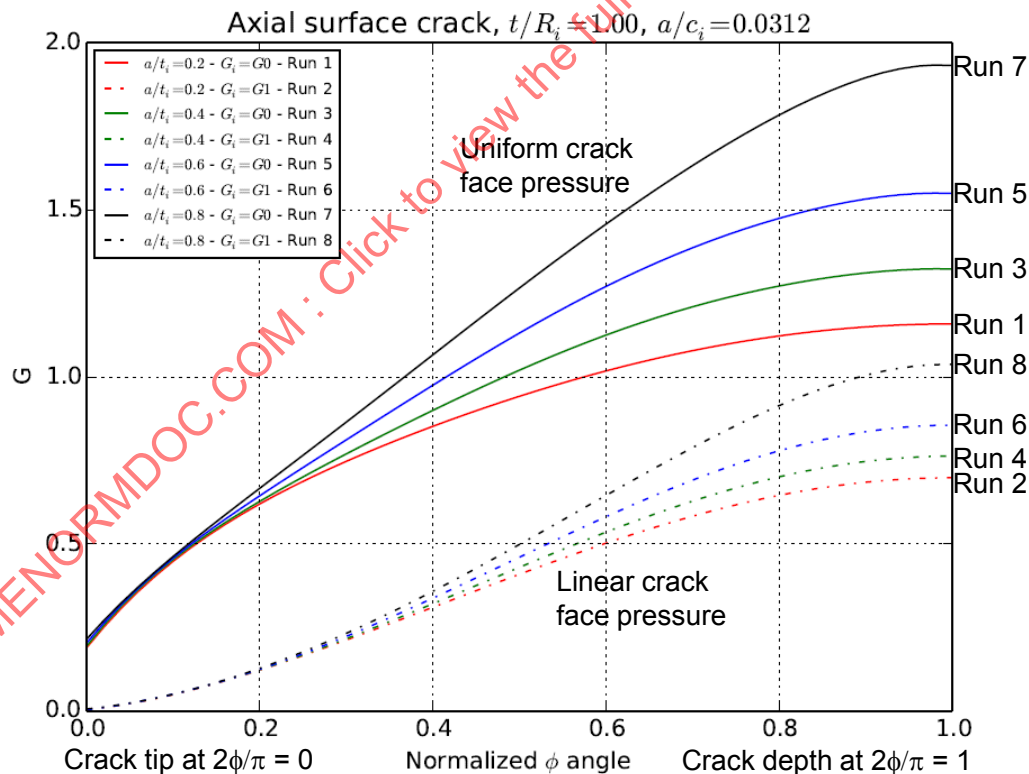


Figure 7-2: Results Plot Example for the Internal Circumferential Surface Crack, Uniform and Linear Crack Face Pressure Load Cases

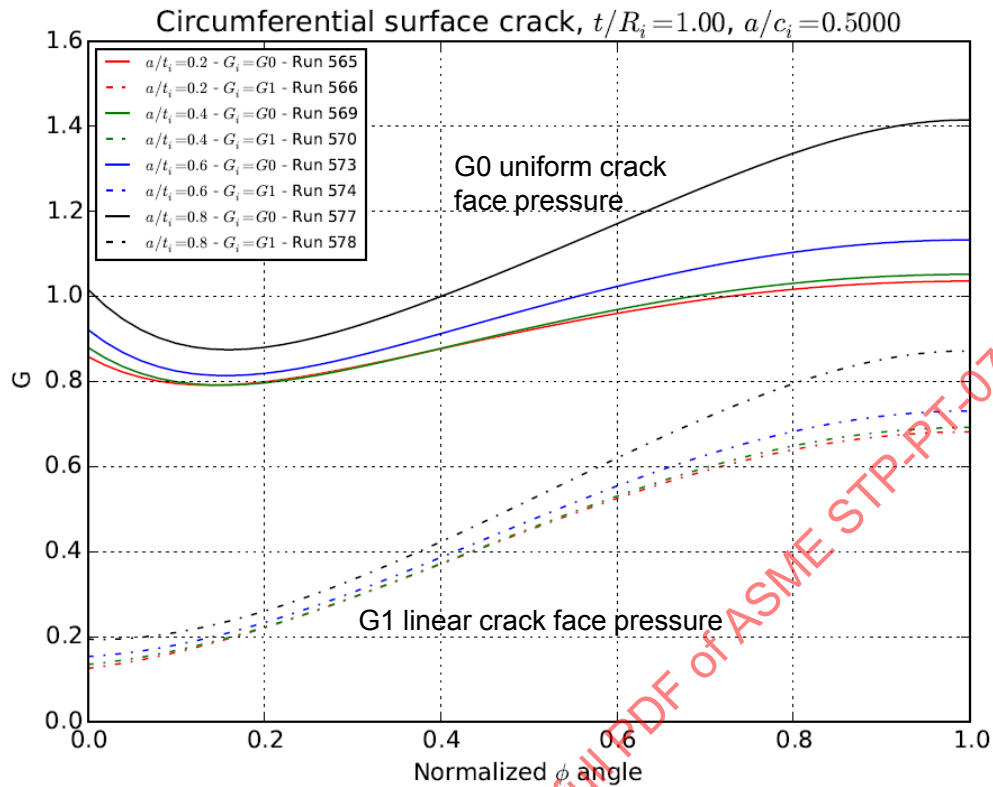
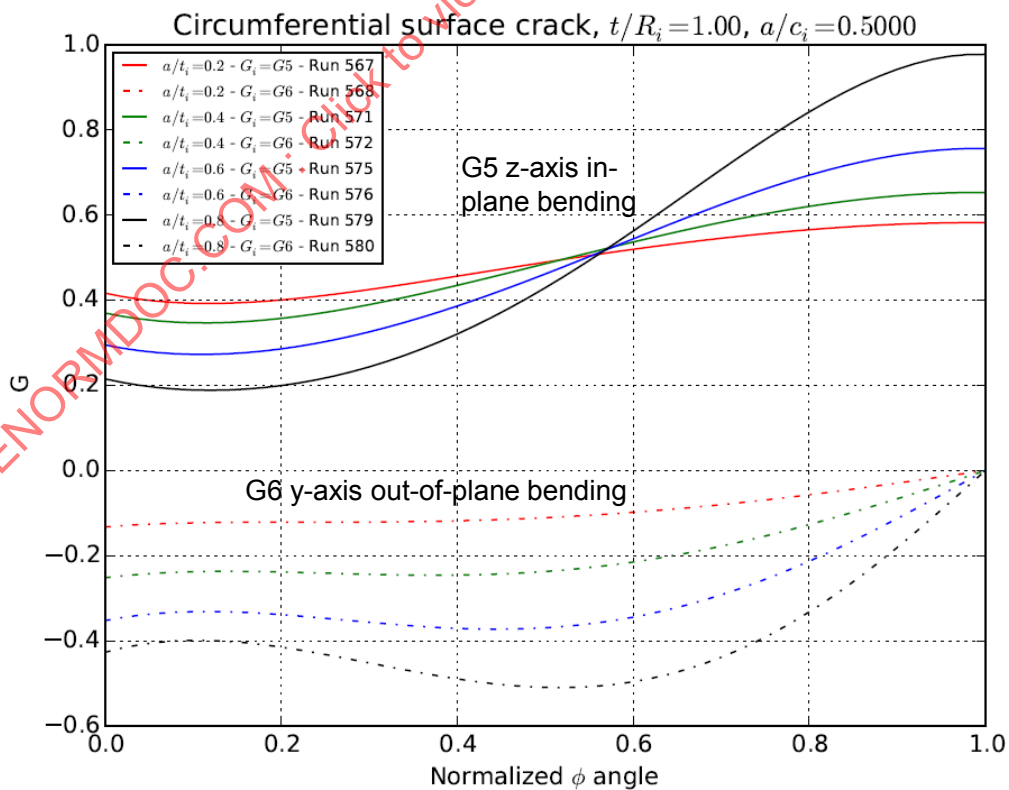


Figure 7-3: Results Plot Example for the Internal Circumferential Surface Crack, In-Plane and Out-of-Plane Bending Load Cases



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.

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: $G_5 = G_{\text{total}} - G_0$

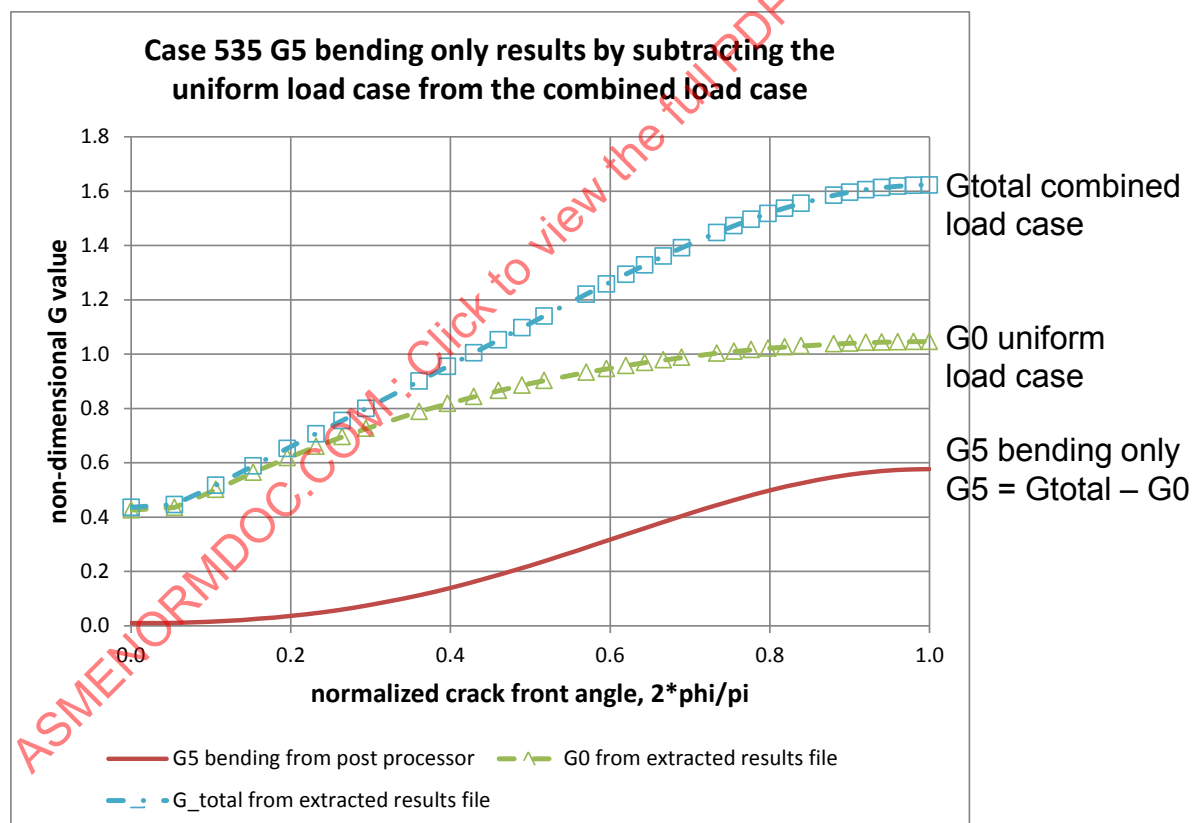
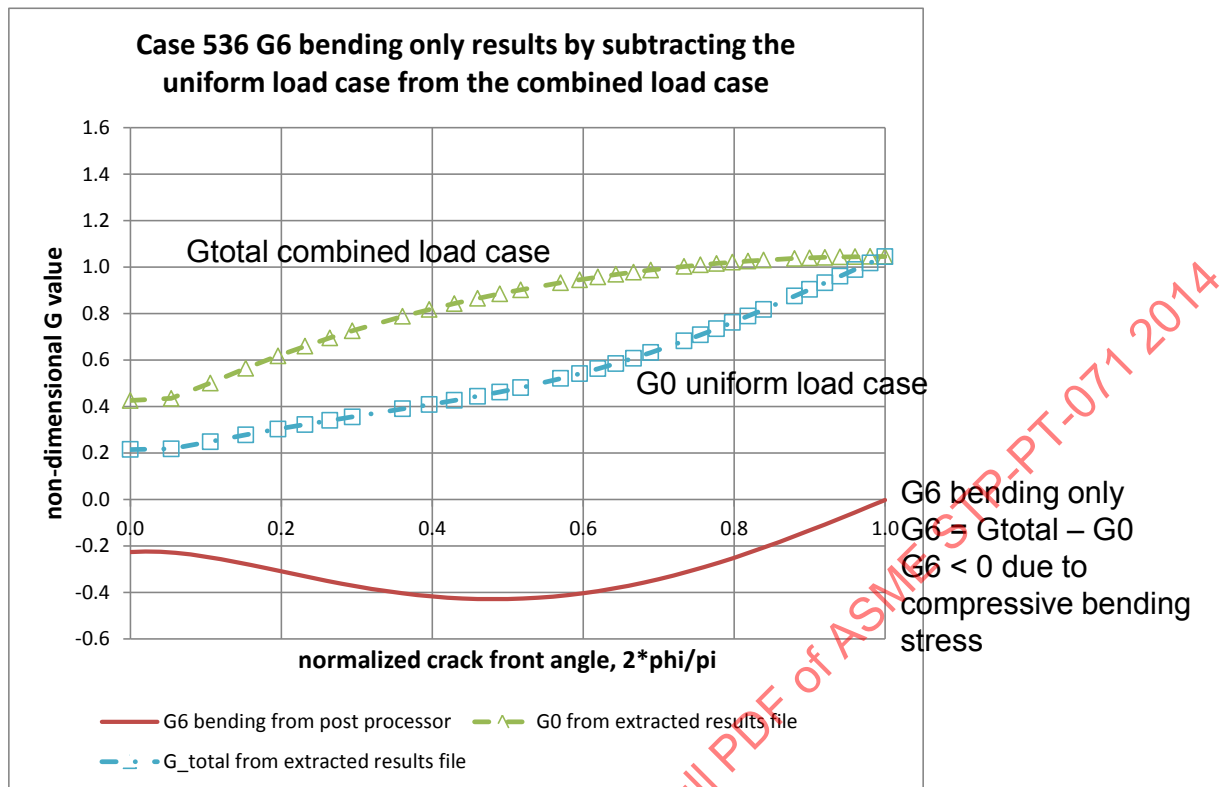
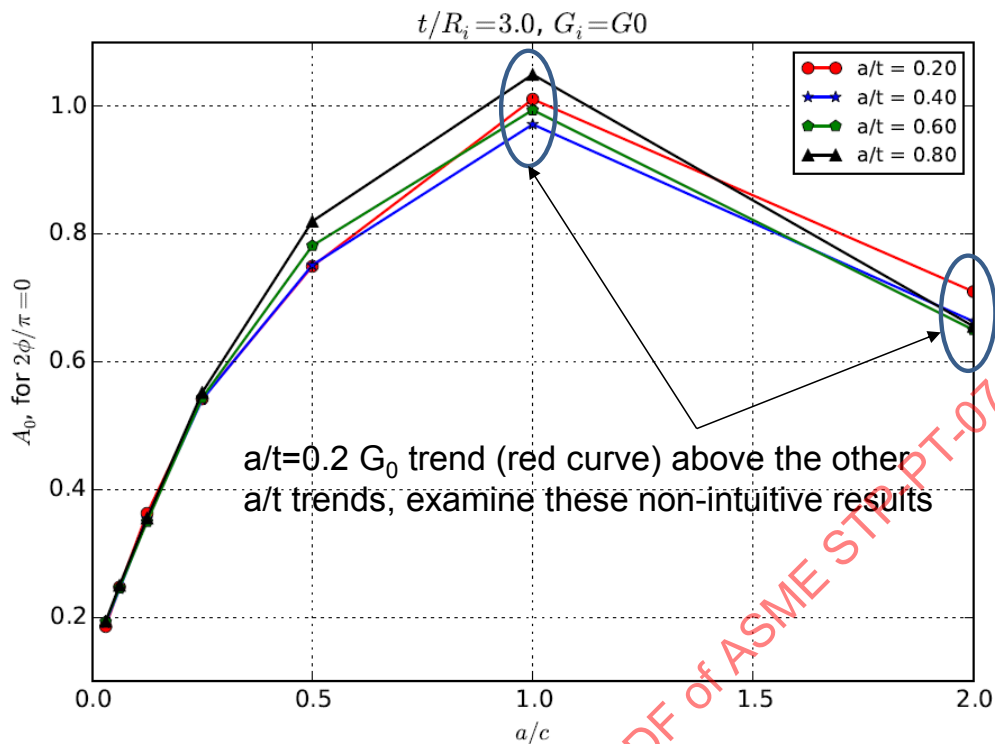


Figure 7-5: Subtract G Result Curves to get Out-of-Plane Bending only Result: $G_6 = G_{total} - G_0$



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 the thicker cylinder cases some result trends were non-intuitive, such as the internal axial surface cracks for $t/R_i = 3$, $a/c = 1$ and 2 (shorter cracks), uniform crack face pressure G_0 load case. In Figure 7-6 the $a/t = 0.2$ shallow crack G_0 trend (red curve) is above the other a/t trends for the shorter a/c ratios. Further examination of the G and K results explains this non-intuitive result trend.

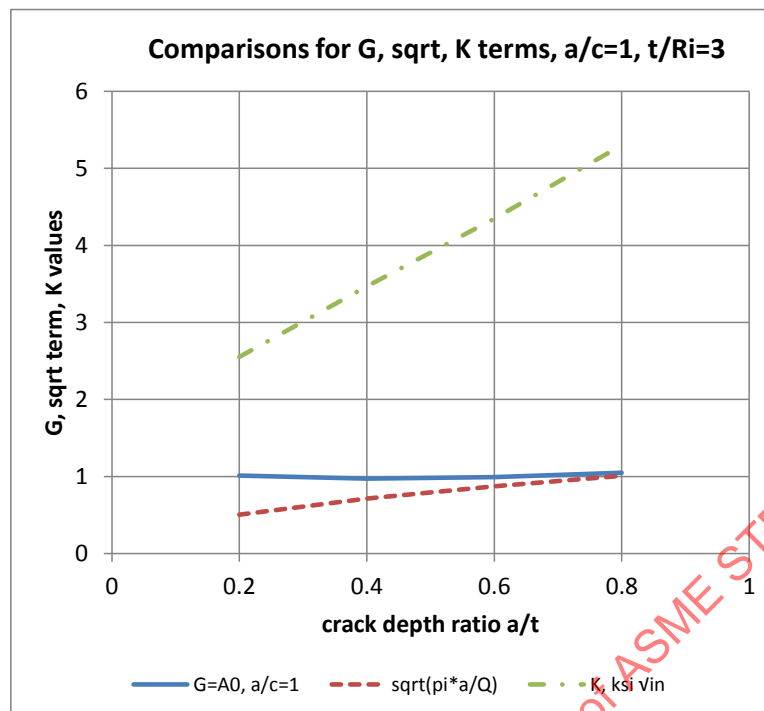
Figure 7-6: Examine the $a/t = 0.2$ G_0 Non-Intuitive Result Trend

The non-dimensional geometry value, G , is computed using the stress intensity K values from the FEA results, the given crack size, and characteristic loading using the general K equation:

$$K = G\sigma\sqrt{\pi a/Q} \quad (5)$$

where K is the stress intensity computed by FEA, σ is the applied characteristic loading (for example, a crack face pressure distribution or bending stress), a is the crack depth, and Q is the shape factor, which is also a function of the crack depth and the crack length. Notice that in the K equation the square root term also varies with the crack size, which can affect the trend of the G values.

The plot in Figure 7-7 compares the non-dimensional G and square root terms for the four a/t ratios and the $a/c = 1$ crack length ratio. Notice that for this set of models the G value is nearly constant (solid blue curve), and the square root term varies more noticeably with the a/t ratio (dashed red curve). Using the G results, the stress intensity K is computed and shows the expected increase in K as the crack depth increases (dot-dash green curve). The stress value $\sigma = 5$ ksi was used to compute the K trend (any load value could be used).

Figure 7-7: Compare the Terms in the K Equation for $a/c = 1$ 

The $a/c = 2$ (shortest crack) G trend is shown in Figure 7-8, and again the square root term varies more than the G term. The K value computed from the G results shows the expected increase in K as the crack depth increases.

For further comparison, the G_0 result trends shown in Figure 7-9 for $t/R_i = 1$ give the more commonly expected ordering of the a/t result curves that G increases as the crack depth increases. Figure 7-10 shows that the G and square root term values vary in a similar manner as the crack depth gets deeper, and again the K value increases as expected as the crack depth increases.

If the square root term in the K equation varies more than the G value, then the non-dimensional G results can give a non-intuitive trend. If the G and square root terms in the K equation vary in a similar magnitude, then the G results give the expected increasing trends. The G result trends should be considered as part of the total stress intensity K solution using the K equation with the other terms to compute K for a given crack size.

Figure 7-8: Compare the Terms in the K Equation for $a/c = 2$

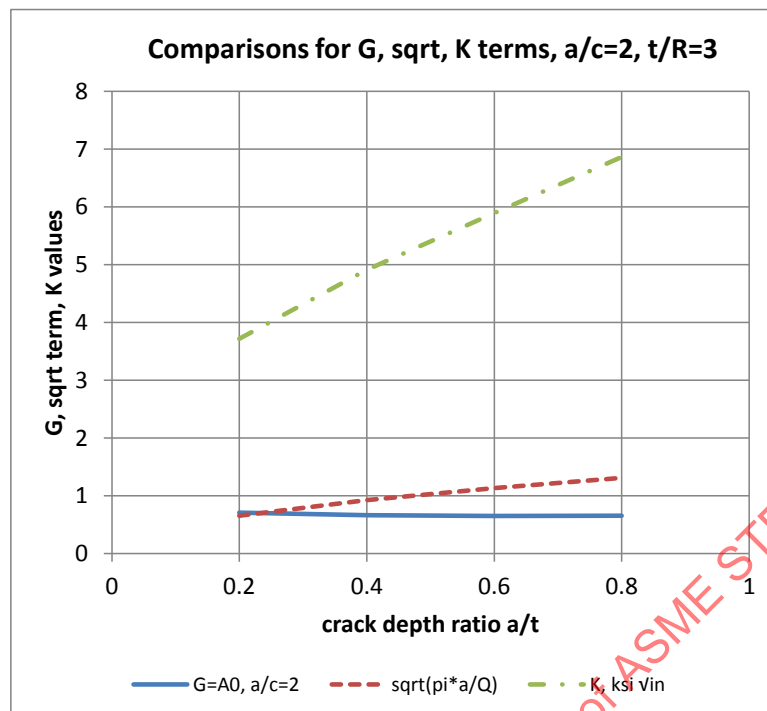


Figure 7-9: A More Typical G_0 Result Trend

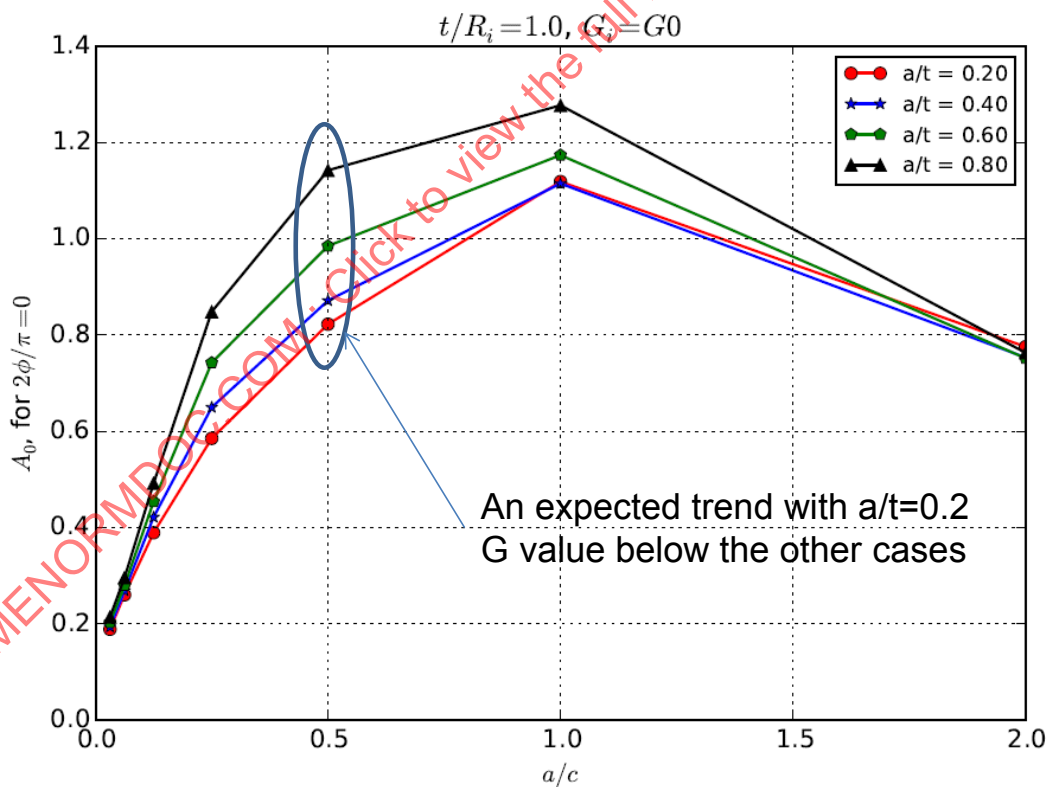
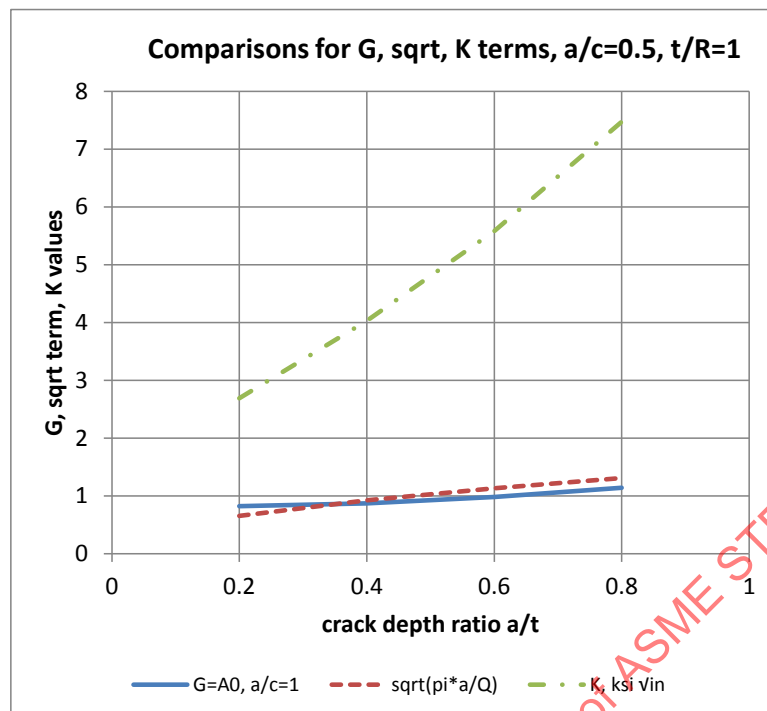
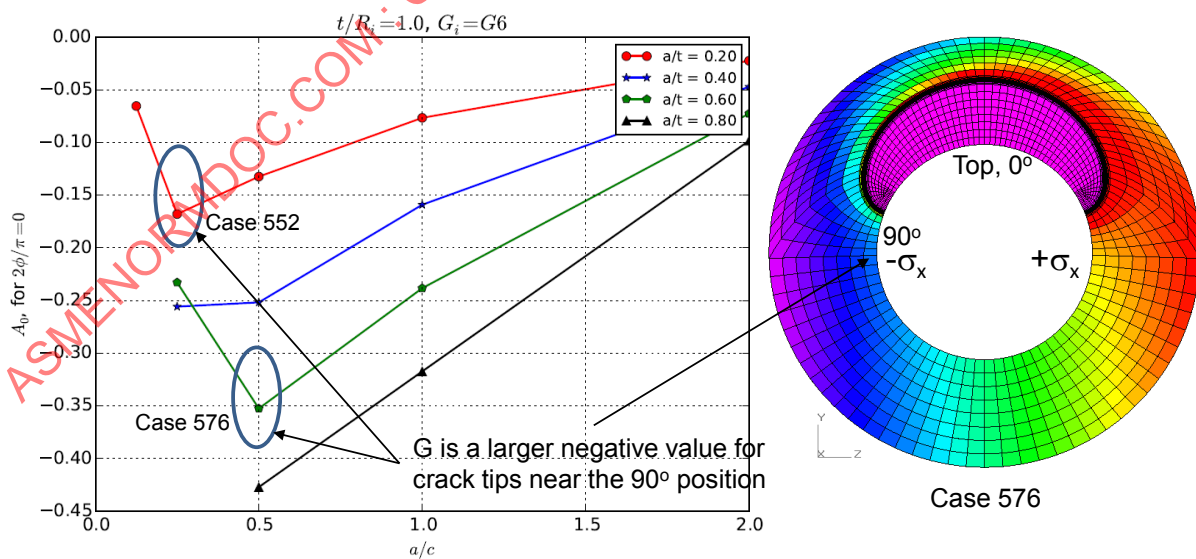


Figure 7-10: Terms in the K Equation for $t/R_i = 1$ 

Another non-intuitive result 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 7-11 shows the G result trend for case 552 and case 576. The G value decreases 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 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. The other a/c ratios give a shorter or longer crack length with the crack tip farther away from the 90° location on the side of the cylinder.

Figure 7-11: Crack Tip G_6 Result Trends for the Out-of-Plane Bending Load Case

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 I crack opening K from displacement is computed using the equation:

$$K_I = 0.25E \frac{U_{\text{total}}}{2} \left(\frac{2\pi}{R} \right)^2 \quad (6)$$

where K_I is the mode I 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 7-12 and Figure 7-13 show plots comparing K from the crack opening displacement to K from the J-integral for eight axial internal 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 7-13 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 7-12: K from Displacement Comparison to K from J for Axial Internal Surface Crack Cases 1, 3, 5, 7, Uniform Crack Face Pressure G0 Load Case

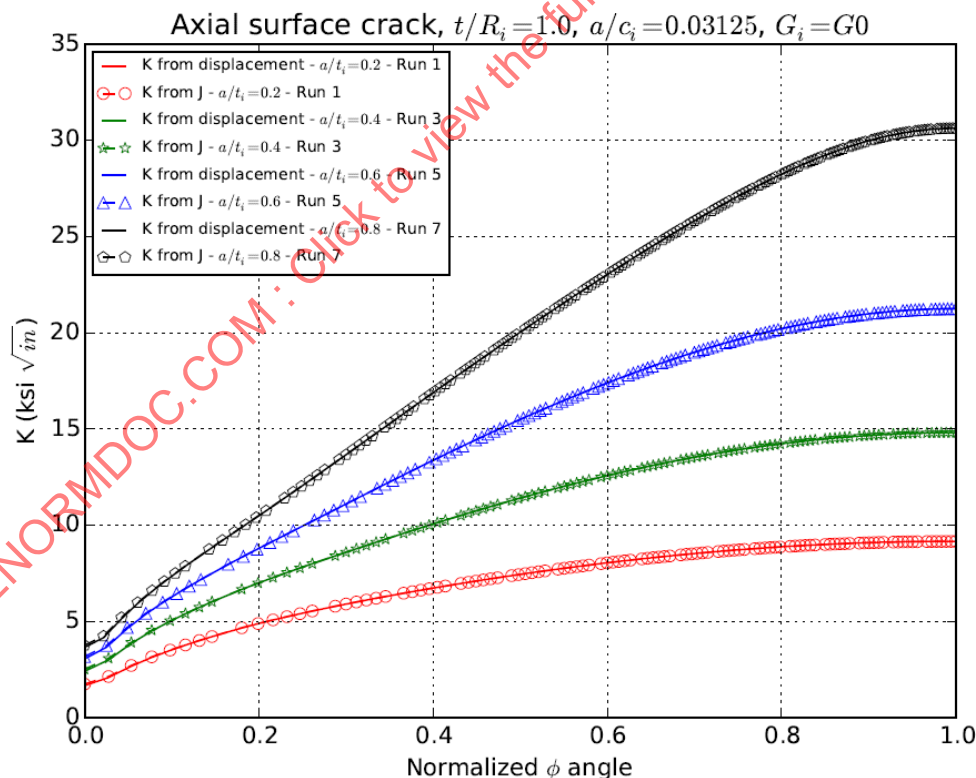
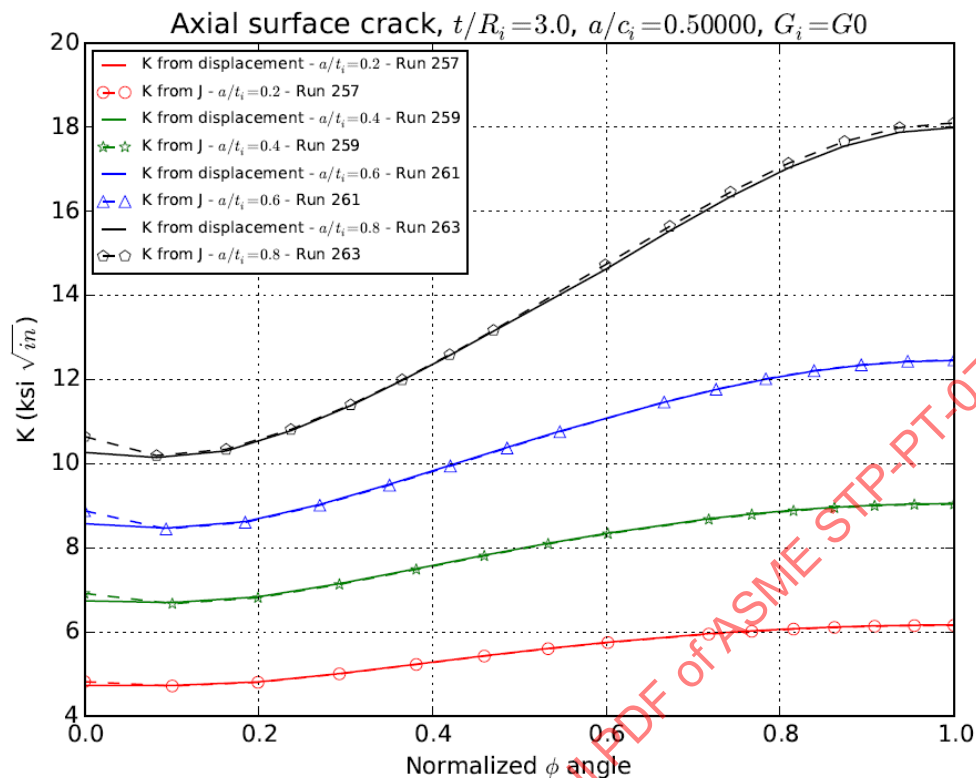


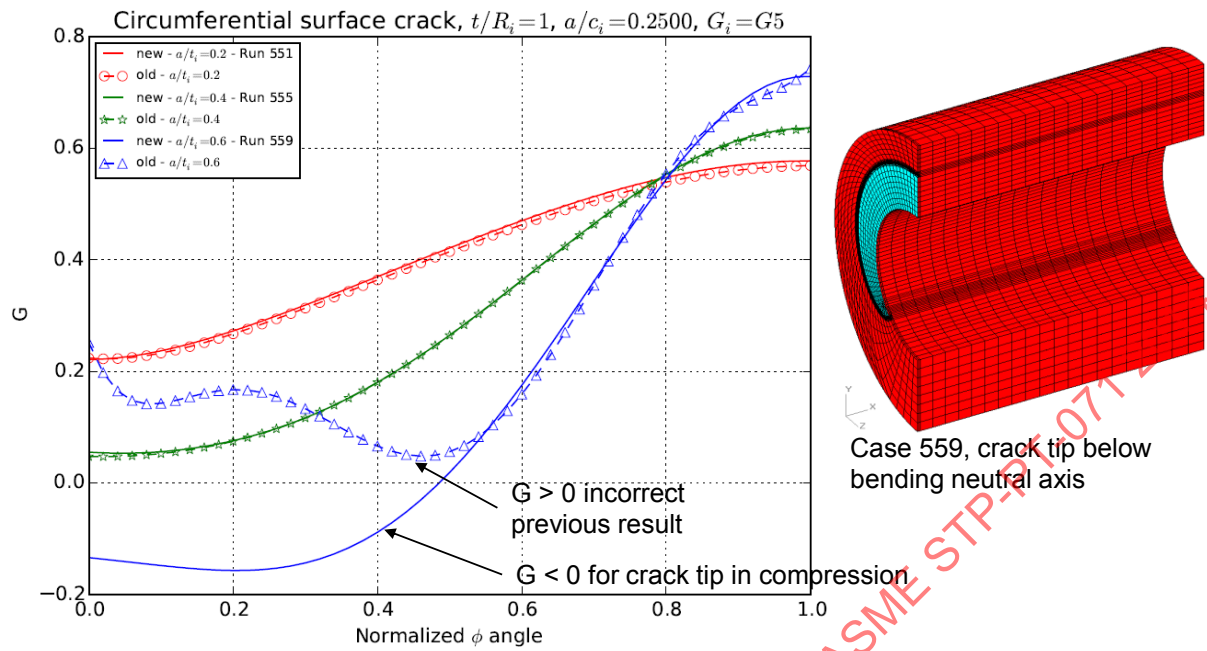
Figure 7-13: K from Displacement Comparison to K from J for Axial Internal Surface Crack Cases 257, 259, 261, 263, Uniform Crack Face Pressure G0 Load Case



7.4 Incorrect Previous Results

The comparison of the results for the $t/R_i = 1$ cases to the previous results generally agree well (see appendices G, I, L and N), except for case 559: $t/R_i = 1$, $a/c = 0.25$, $a/t = 0.6$, in-plane bending G5, where the result trend was very different for part of the crack front. In Figure 7-14 the solid blue curve shows the new result along the crack front angle, and the previous results are shown by the blue dashed curve with the triangle data points. The new G5 result is negative for part of the crack front near the crack tip. The crack length is long enough that the crack tip is below the bending neutral axis for the in-plane bending load case, which puts the crack tip into compression. By using the combined bending plus axial load and then subtracting the uniform load case results, the correct negative G5 results are obtained for this case. It is likely that the previous results did not account for the crack tip compression, which gave a positive G result near the crack tip.

Figure 7-14: Results for Case 559 Show a Previous Result Error



8 SUMMARY

Stress intensity K factors were computed for internal cracks in thick-walled cylinders. The 744 cases include a range of geometry ratios and crack size ratios for internal axial and internal circumferential surface cracks, axial internal full-width partial depth axial cracks, and circumferential internal 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 FEA 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.

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.

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APPENDIX A - AXIAL INTERNAL SURFACE 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 1. Non-Dimensional Geometry Polynomial Coefficient Values for Axial Internal Surface Cracks

Run ID	Y=O D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
1	2.0	0.01563	1.0	0.03125	0.2	G0	0.18877705	3.24601261	-7.96571189	15.80393118	-18.60110823	11.25741445	-2.77088858
2	2.0	0.01563	1.0	0.03125	0.2	G1	0.00353150	0.25578270	2.24886029	-3.41822578	3.37293372	-2.60952867	0.84487291
3	2.0	0.01563	1.0	0.03125	0.4	G0	0.19360576	3.32561028	-9.32850476	23.26970364	-32.01584092	21.74781962	-5.86925401
4	2.0	0.01563	1.0	0.03125	0.4	G1	0.00319127	0.29493099	1.84846308	-1.88124442	1.50936466	-1.69863976	0.68686504
5	2.0	0.01563	1.0	0.03125	0.6	G0	0.20275928	3.19723165	-8.55287018	24.16364445	-35.83441962	25.59624401	-7.22306657
6	2.0	0.01563	1.0	0.03125	0.6	G1	0.00359242	0.30181494	1.68680411	-0.82097424	0.11471210	-0.91344193	0.48316625
7	2.0	0.01563	1.0	0.03125	0.8	G0	0.21444151	2.93323859	-6.24024485	19.70777544	-31.40509498	24.50620566	-7.78389921
8	2.0	0.01563	1.0	0.03125	0.8	G1	0.00541267	0.25771050	1.96232858	-1.05646222	0.18321760	-0.08230479	-0.23256239
9	2.0	0.03125	1.0	0.0625	0.2	G0	0.26027143	2.50723699	-4.01963396	4.86049618	-3.16144113	0.52627351	0.16263936
10	2.0	0.03125	1.0	0.0625	0.2	G1	0.01406790	0.26180081	2.20801810	-3.34915659	3.04773577	-2.15774665	0.66225623
11	2.0	0.03125	1.0	0.0625	0.4	G0	0.26880224	2.67345368	-5.64469561	11.35403327	-12.53333237	6.47766814	-1.28172705
12	2.0	0.03125	1.0	0.0625	0.4	G1	0.01592632	0.29064464	2.01419638	-2.86165492	3.24826665	-2.98806684	1.03759464
13	2.0	0.03125	1.0	0.0625	0.6	G0	0.27982513	2.71738746	-6.51961455	17.30162975	-23.16751064	14.54847265	-3.61241827
14	2.0	0.03125	1.0	0.0625	0.6	G1	0.01670898	0.30990564	1.78740359	-1.89523443	2.51468205	-3.03411965	1.15417937
15	2.0	0.03125	1.0	0.0625	0.8	G0	0.29583910	2.57093236	-5.80643027	18.88026486	-28.54665227	20.78975184	-6.24932848
16	2.0	0.03125	1.0	0.0625	0.8	G1	0.01841342	0.28787362	1.85593151	-1.59051535	2.10141803	-2.13646006	0.50092281
17	2.0	0.0625	1.0	0.125	0.2	G0	0.38920221	1.30312413	1.24262113	-7.64301332	12.60140425	-9.59198843	2.78825889
18	2.0	0.0625	1.0	0.125	0.2	G1	0.03572147	0.24814587	2.08264421	-2.94328117	2.22131150	-1.38651037	0.41119592
19	2.0	0.0625	1.0	0.125	0.4	G0	0.42156754	1.38236968	0.78624669	-6.27682654	12.08843403	-10.40897681	3.26834156

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
20	2.0	0.0625	1.0	0.125	0.4	G1	0.04697090	0.26007488	2.12112272	-3.27935771	3.44977589	-2.73245745	0.86737898
21	2.0	0.0625	1.0	0.125	0.6	G0	0.45374469	1.34784303	0.73803852	-4.85901447	11.11185412	-11.05856793	3.77684723
22	2.0	0.0625	1.0	0.125	0.6	G1	0.05461140	0.23887474	2.27996675	-3.85461143	5.41422818	-4.90491954	1.60688572
23	2.0	0.0625	1.0	0.125	0.8	G0	0.49200038	1.12555047	1.66093291	-5.03258220	11.02798398	-10.71768034	3.35783495
24	2.0	0.0625	1.0	0.125	0.8	G1	0.06141133	0.16642121	2.76125336	-5.28233654	8.46842183	-7.15847500	2.00838342
25	2.0	0.125	1.0	0.25	0.2	G0	0.58525652	-0.10000313	5.38617298	-14.48172056	18.70592607	-12.30900735	3.25345816
26	2.0	0.125	1.0	0.25	0.2	G1	0.07245400	0.20565627	1.89194823	-2.32294123	1.26481851	-0.65024834	0.19547726
27	2.0	0.125	1.0	0.25	0.4	G0	0.64969157	-0.18785194	5.84133906	-15.67286103	20.88136986	-14.20898369	3.84550899
28	2.0	0.125	1.0	0.25	0.4	G1	0.09732754	0.16686056	2.11521406	-2.95922768	2.35046534	-1.52989790	0.45507532
29	2.0	0.125	1.0	0.25	0.6	G0	0.74235185	-0.49786034	7.42252907	-19.52484644	27.42257816	-19.75695902	5.56042922
30	2.0	0.125	1.0	0.25	0.6	G1	0.12658284	0.07208596	2.64948813	-4.45082349	5.09665908	-3.86373971	1.15262098
31	2.0	0.125	1.0	0.25	0.8	G0	0.84823214	-1.03014321	10.27345371	-26.71532844	39.52192086	-29.40393600	8.26607667
32	2.0	0.125	1.0	0.25	0.8	G1	0.15665648	-0.10057273	3.72058015	-7.63688015	10.81463330	-8.23531994	2.24477178
33	2.0	0.25	1.0	0.5	0.2	G0	0.82237764	-0.69268152	4.17493124	-7.93886159	8.14378838	-4.59362986	1.09292185
34	2.0	0.25	1.0	0.5	0.2	G1	0.11878883	0.32915006	1.06843027	-0.64754330	-0.52476034	0.36630726	-0.04253290
35	2.0	0.25	1.0	0.5	0.4	G0	0.87146131	-0.79857968	4.44560799	-8.31114453	8.48373443	-4.78181094	1.13663697
36	2.0	0.25	1.0	0.5	0.4	G1	0.14000514	0.27626198	1.20506110	-0.85463433	-0.32380023	0.25547274	-0.01733869
37	2.0	0.25	1.0	0.5	0.6	G0	0.98493138	-1.12124911	5.61929254	-10.55105544	11.33691086	-6.78246084	1.68439488
38	2.0	0.25	1.0	0.5	0.6	G1	0.17998550	0.15995023	1.63907136	-1.71288895	0.82726905	-0.56463775	0.20241375
39	2.0	0.25	1.0	0.5	0.8	G0	1.14200488	-1.65971653	7.90078468	-15.43972630	18.28701883	-11.72804591	2.94306808
40	2.0	0.25	1.0	0.5	0.8	G1	0.23280068	-0.04672961	2.66115391	-4.23250461	4.66108983	-3.24143607	0.82820643
41	2.0	0.5	1.0	1	0.2	G0	1.11854021	-0.74661164	2.25699655	-4.29236585	4.97324629	-3.14993354	0.82913700
42	2.0	0.5	1.0	1	0.2	G1	0.16791434	0.55763207	1.07885854	-2.13611768	1.80245286	-1.03154235	0.27399933
43	2.0	0.5	1.0	1	0.4	G0	1.11451900	-0.75429912	2.40596443	-4.70328880	5.53276057	-3.53809119	0.93677714
44	2.0	0.5	1.0	1	0.4	G1	0.17288505	0.51610164	1.25965101	-2.54418070	2.32165346	-1.37902768	0.36819189
45	2.0	0.5	1.0	1	0.6	G0	1.17355270	-0.91077179	3.00095221	-5.85218459	6.80374236	-4.29749676	1.12458586
46	2.0	0.5	1.0	1	0.6	G1	0.19624697	0.44243716	1.53879494	-3.06791947	2.90346713	-1.73257655	0.45601380
47	2.0	0.5	1.0	1	0.8	G0	1.27696615	-1.15931681	4.13564963	-8.23430236	9.82439383	-6.29876683	1.63189198

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=O D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
48	2.0	0.5	1.0	1	0.8	G1	0.23163367	0.35961119	1.96240932	-3.93422158	4.04856964	-2.46988489	0.61137748
49	2.0	1	1.0	2	0.2	G0	0.77554178	-0.46216998	0.92896725	-1.91376971	1.75673954	-0.96298213	0.35928442
50	2.0	1	1.0	2	0.2	G1	0.09738392	0.52648571	0.55991515	-1.02300569	-0.43892440	0.82673236	-0.15596843
51	2.0	1	1.0	2	0.4	G0	0.75313334	-0.38897875	0.88897431	-2.08260345	2.12412287	-1.26858744	0.45480859
52	2.0	1	1.0	2	0.4	G1	0.09450969	0.51890942	0.65650062	-1.30446378	-0.04035567	0.53691111	-0.07018306
53	2.0	1	1.0	2	0.6	G0	0.75173765	-0.36330010	0.94721673	-2.34803300	2.47636422	-1.47438544	0.50057059
54	2.0	1	1.0	2	0.6	G1	0.09708005	0.50609381	0.75153449	-1.52275735	0.19970618	0.41135427	-0.04598244
55	2.0	1	1.0	2	0.8	G0	0.76311423	-0.32820138	0.95972777	-2.37935468	2.42721524	-1.39758430	0.47505888
56	2.0	1	1.0	2	0.8	G1	0.10183627	0.51405449	0.78335525	-1.54681939	0.18629603	0.43672464	-0.05822519
57	2.5	0.01563	1.5	0.03125	0.2	G0	0.18714817	3.21932332	-8.35474523	17.17530552	-20.94269416	13.16803918	-3.35482152
58	2.5	0.01563	1.5	0.03125	0.2	G1	0.00300566	0.25540015	2.17447033	-3.27426463	3.12193758	-2.37573021	0.77028556
59	2.5	0.01563	1.5	0.03125	0.4	G0	0.19249652	3.16028722	-8.95520619	22.10756468	-30.88292517	21.55858023	-5.98533093
60	2.5	0.01563	1.5	0.03125	0.4	G1	0.00262303	0.28279215	1.80225011	-1.80107384	1.06005207	-1.07431392	0.44267235
61	2.5	0.01563	1.5	0.03125	0.6	G0	0.20079859	2.91473577	-7.28252155	18.92637619	-27.28494733	19.42251461	-5.53442191
62	2.5	0.01563	1.5	0.03125	0.6	G1	0.00341475	0.26333687	1.85892066	-1.66245598	1.11428967	-1.28542200	0.49556470
63	2.5	0.01563	1.5	0.03125	0.8	G0	0.20891525	2.62419304	-4.73368750	12.14424271	-17.29485294	13.15012575	-4.38953440
64	2.5	0.01563	1.5	0.03125	0.8	G1	0.00545197	0.19745454	2.36051792	-3.03866481	3.34978356	-2.22951166	0.31391148
65	2.5	0.03125	1.5	0.0625	0.2	G0	0.25590746	2.47698433	-4.35043343	5.89193699	-4.60705013	1.52281690	-0.10473721
66	2.5	0.03125	1.5	0.0625	0.2	G1	0.01300064	0.25430859	2.17123031	-3.34669877	3.11209132	-2.21504369	0.67944777
67	2.5	0.03125	1.5	0.0625	0.4	G0	0.25866133	2.56145820	-5.90141752	12.72182781	-15.47020840	9.19262335	-2.16788988
68	2.5	0.03125	1.5	0.0625	0.4	G1	0.01314043	0.27629968	1.90580717	-2.55492426	2.63252555	-2.41338227	0.85430809
69	2.5	0.03125	1.5	0.0625	0.6	G0	0.26567242	2.47340864	-5.98958215	16.08408488	-22.64594006	15.27260664	-4.09488907
70	2.5	0.03125	1.5	0.0625	0.6	G1	0.01316329	0.28152129	1.72867366	-1.71498233	1.82044573	-2.17229108	0.83215150
71	2.5	0.03125	1.5	0.0625	0.8	G0	0.27758860	2.19336325	-4.17582088	13.09689456	-20.08626719	15.38513635	-4.97789805
72	2.5	0.03125	1.5	0.0625	0.8	G1	0.01465808	0.23498151	1.99729582	-2.21581431	2.66152788	-2.11071082	0.37887092
73	2.5	0.0625	1.5	0.125	0.2	G0	0.38187537	1.28359347	0.99801803	-7.00462296	11.89543928	-9.20621292	2.70296719
74	2.5	0.0625	1.5	0.125	0.2	G1	0.03435858	0.24180354	2.05019799	-2.93865188	2.29147647	-1.45654608	0.43235029
75	2.5	0.0625	1.5	0.125	0.4	G0	0.39612141	1.30717290	0.43683667	-4.88890285	9.92772201	-8.84381916	2.83926831

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
76	2.5	0.0625	1.5	0.125	0.4	G1	0.03996303	0.23684144	2.06413686	-3.14632462	3.31917495	-2.66365006	0.85349179
77	2.5	0.0625	1.5	0.125	0.6	G0	0.40892230	1.23354812	0.36368211	-2.97365975	7.41022452	-7.86369928	2.78186329
78	2.5	0.0625	1.5	0.125	0.6	G1	0.04212630	0.21014093	2.18007448	-3.53506733	4.86020234	-4.43758685	1.46505736
79	2.5	0.0625	1.5	0.125	0.8	G0	0.42933797	0.98188968	1.48659176	-3.80639255	7.83896742	-7.38712228	2.17300821
80	2.5	0.0625	1.5	0.125	0.8	G1	0.04480419	0.14019084	2.63572541	-4.90681557	7.70015611	-6.39882072	1.74529066
81	2.5	0.125	1.5	0.25	0.2	G0	0.57312593	-0.10268091	5.23487180	-14.16692620	18.42038649	-12.18078902	3.23042994
82	2.5	0.125	1.5	0.25	0.2	G1	0.07029886	0.20070677	1.86929514	-2.30965987	1.28453234	-0.67058944	0.20101357
83	2.5	0.125	1.5	0.25	0.4	G0	0.61436525	-0.19256028	5.55955449	-14.83773586	19.88991016	-13.65196121	3.71926383
84	2.5	0.125	1.5	0.25	0.4	G1	0.08836934	0.15737568	2.06644860	-2.83876601	2.26111535	-1.51130301	0.45669947
85	2.5	0.125	1.5	0.25	0.6	G0	0.66542756	-0.46033154	6.89765249	-17.92659270	25.34470398	-18.47556217	5.24708105
86	2.5	0.125	1.5	0.25	0.6	G1	0.10465693	0.07129199	2.54904197	-4.19330528	4.87553227	-3.79494737	1.14743879
87	2.5	0.125	1.5	0.25	0.8	G0	0.71875796	-0.86845537	9.23646887	-23.83474577	35.66160255	-26.82722941	7.56953275
88	2.5	0.125	1.5	0.25	0.8	G1	0.11882864	-0.06791292	3.49585650	-7.13847079	10.35717743	-8.02700426	2.19596880
89	2.5	0.25	1.5	0.5	0.2	G0	0.79999341	-0.67020822	4.07079825	-7.74238698	7.92675651	-4.45694420	1.05636626
90	2.5	0.25	1.5	0.5	0.2	G1	0.11369425	0.32751435	1.05610509	-0.62228699	-0.55861503	0.39468862	-0.05188629
91	2.5	0.25	1.5	0.5	0.4	G0	0.83405837	-0.76793192	4.37489574	-8.19956763	8.41489024	-4.78098603	1.14451936
92	2.5	0.25	1.5	0.5	0.4	G1	0.13167273	0.26852254	1.23199740	-0.91433958	-0.23718722	0.19074030	0.00103691
93	2.5	0.25	1.5	0.5	0.6	G0	0.91908387	-1.05561276	5.59218396	-10.64765768	11.70354444	-7.17836456	1.81634924
94	2.5	0.25	1.5	0.5	0.6	G1	0.16392756	0.15412483	1.71792813	-1.92786803	1.18142016	-0.84985255	0.28619794
95	2.5	0.25	1.5	0.5	0.8	G0	1.03003947	-1.49498842	7.81051456	-15.76003267	19.46449771	-12.94090151	3.33175046
96	2.5	0.25	1.5	0.5	0.8	G1	0.20370479	-0.03262156	2.77284630	-4.66254764	5.50195103	-3.95488100	1.03763301
97	2.5	0.5	1.5	1	0.2	G0	1.08527150	-0.69576608	2.21729465	-4.30202610	5.01002174	-3.17316096	0.83351801
98	2.5	0.5	1.5	1	0.2	G1	0.16003173	0.55598628	1.11979553	-2.23728489	1.92094775	-1.10187853	0.29081254
99	2.5	0.5	1.5	1	0.4	G0	1.06776949	-0.67007720	2.36074131	-4.79414585	5.71010947	-3.66161734	0.96794165
100	2.5	0.5	1.5	1	0.4	G1	0.16286386	0.51146726	1.34356619	-2.75490928	2.57501251	-1.53316838	0.40591908
101	2.5	0.5	1.5	1	0.6	G0	1.11578454	-0.78769937	2.96789724	-6.10666616	7.28283817	-4.66170397	1.22652655
102	2.5	0.5	1.5	1	0.6	G1	0.18486461	0.43758439	1.67513598	-3.43510366	3.38298512	-2.04949959	0.53947179
103	2.5	0.5	1.5	1	0.8	G0	1.20688966	-0.98261357	4.15851409	-8.91871624	11.17664562	-7.40498727	1.95770216

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
104	2.5	0.5	1.5	1	0.8	G1	0.21931761	0.35451785	2.19200736	-4.62164228	5.06323519	-3.20807364	0.81834918
105	2.5	1	1.5	2	0.2	G0	0.75615664	-0.41133334	0.89227378	-1.97737447	1.91107028	-1.08921570	0.39721314
106	2.5	1	1.5	2	0.2	G1	0.09336331	0.52722310	0.59965878	-1.14372960	-0.27250707	0.70953409	-0.12219865
107	2.5	1	1.5	2	0.4	G0	0.72418609	-0.29551405	0.77402685	-2.07604265	2.25761768	-1.40808502	0.50160691
108	2.5	1	1.5	2	0.4	G1	0.08898216	0.52195757	0.71109389	-1.48303819	0.21330853	0.35495002	-0.01698731
109	2.5	1	1.5	2	0.6	G0	0.71762836	-0.23202652	0.74551327	-2.23140682	2.53304941	-1.59104434	0.54716494
110	2.5	1	1.5	2	0.6	G1	0.09117126	0.51234380	0.81227978	-1.73861270	0.51682240	0.17962389	0.02247882
111	2.5	1	1.5	2	0.8	G0	0.72696543	-0.16543494	0.70813601	-2.26295090	2.59017889	-1.64148173	0.56848675
112	2.5	1	1.5	2	0.8	G1	0.09671534	0.52073480	0.86940518	-1.85984670	0.66639548	0.07455000	0.05047334
113	3.0	0.01563	2.0	0.03125	0.2	G0	0.18624312	3.18718621	-8.61635344	18.18866470	-22.75344397	14.69690998	-3.83723625
114	3.0	0.01563	2.0	0.03125	0.2	G1	0.00267769	0.25625219	2.10519023	-3.12020558	2.85437295	-2.13213659	0.69151166
115	3.0	0.01563	2.0	0.03125	0.4	G0	0.19209903	3.01770629	-8.48844920	20.53607952	-28.58379035	20.06180136	-5.61740197
116	3.0	0.01563	2.0	0.03125	0.4	G1	0.00246162	0.27006961	1.81319832	-1.92846417	1.12564649	-0.97437591	0.37734655
117	3.0	0.01563	2.0	0.03125	0.6	G0	0.19839928	2.74093407	-6.57461069	15.93599378	-22.02583006	15.29701971	-4.31158211
118	3.0	0.01563	2.0	0.03125	0.6	G1	0.00333893	0.23948432	1.97248294	-2.27279437	2.03910081	-1.86176641	0.63052752
119	3.0	0.01563	2.0	0.03125	0.8	G0	0.20311282	2.48223554	-4.32029136	9.58838452	-12.00203917	8.55995198	-2.92418559
120	3.0	0.01563	2.0	0.03125	0.8	G1	0.00518072	0.17304784	2.49595606	-3.88583823	4.83181257	-3.33533951	0.63054628
121	3.0	0.03125	2.0	0.0625	0.2	G0	0.25241415	2.44889603	-4.62427366	6.85536542	-6.08310420	2.60442944	-0.40817331
122	3.0	0.03125	2.0	0.0625	0.2	G1	0.01218569	0.25002202	2.12546611	-3.28294849	3.06332928	-2.18814526	0.67369530
123	3.0	0.03125	2.0	0.0625	0.4	G0	0.25239748	2.45670680	-5.86960135	13.09378750	-16.72282945	10.57743485	-2.66778727
124	3.0	0.03125	2.0	0.0625	0.4	G1	0.01158521	0.26713051	1.83219884	-2.32462940	2.14807518	-1.94894991	0.70095381
125	3.0	0.03125	2.0	0.0625	0.6	G0	0.25740055	2.27972147	-5.26235811	13.91612704	-19.87874259	13.75303877	-3.80121606
126	3.0	0.03125	2.0	0.0625	0.6	G1	0.01145982	0.25991065	1.74158276	-1.77381339	1.67460678	-1.85243265	0.69090689
127	3.0	0.03125	2.0	0.0625	0.8	G0	0.26629148	1.95486935	-2.95649114	8.56940916	-12.79518810	10.02727446	-3.47538140
128	3.0	0.03125	2.0	0.0625	0.8	G1	0.01291212	0.20131688	2.13000250	-2.78662577	3.39512775	-2.47484931	0.43958741
129	3.0	0.0625	2.0	0.125	0.2	G0	0.37487347	1.26397115	0.79048902	-6.37142739	11.08917087	-8.70557915	2.57902443
130	3.0	0.0625	2.0	0.125	0.2	G1	0.03297416	0.23608867	2.01801371	-2.90298069	2.30128358	-1.48446675	0.44293694
131	3.0	0.0625	2.0	0.125	0.4	G0	0.37814859	1.24931762	0.24474994	-3.94387979	8.24013074	-7.50126646	2.44629104

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
132	3.0	0.0625	2.0	0.125	0.4	G1	0.03533717	0.22245895	2.01690617	-3.00469672	3.11041685	-2.50897061	0.81111678
133	3.0	0.0625	2.0	0.125	0.6	G0	0.38216189	1.15265793	0.29529170	-2.24301113	5.53823744	-6.01934269	2.16250656
134	3.0	0.0625	2.0	0.125	0.6	G1	0.03542630	0.19563745	2.11528984	-3.29928134	4.37900217	-3.99927947	1.32664115
135	3.0	0.0625	2.0	0.125	0.8	G0	0.39493745	0.88710001	1.64863942	-4.02455553	7.30839815	-6.32743434	1.71201951
136	3.0	0.0625	2.0	0.125	0.8	G1	0.03678471	0.12831527	2.56846945	-4.68060946	7.14432220	-5.82586458	1.54929755
137	3.0	0.125	2.0	0.25	0.2	G0	0.56180287	-0.10353819	5.09889215	-13.83480421	18.06248610	-11.98912659	3.18868105
138	3.0	0.125	2.0	0.25	0.2	G1	0.06822362	0.19651662	1.84843951	-2.28159570	1.27680496	-0.67459995	0.20311916
139	3.0	0.125	2.0	0.25	0.4	G0	0.58495278	-0.19117947	5.36126810	-14.20310133	19.04580534	-13.11677475	3.58438585
140	3.0	0.125	2.0	0.25	0.4	G1	0.08093941	0.15072333	2.03429376	-2.74474258	2.16655222	-1.46821350	0.44861005
141	3.0	0.125	2.0	0.25	0.6	G0	0.61181609	-0.41815168	6.55056838	-16.90535161	23.89443037	-17.47841739	4.98078404
142	3.0	0.125	2.0	0.25	0.6	G1	0.08979902	0.07426074	2.48300328	-4.02774184	4.69506141	-3.69827748	1.12587411
143	3.0	0.125	2.0	0.25	0.8	G0	0.64078467	-0.73940848	8.55211220	-22.04828632	33.08206859	-24.94176512	7.03061212
144	3.0	0.125	2.0	0.25	0.8	G1	0.09690156	-0.04140983	3.34115391	-6.80144599	9.95802170	-7.76630025	2.12326297
145	3.0	0.25	2.0	0.5	0.2	G0	0.78082131	-0.64814664	3.98205659	-7.57179065	7.73841287	-4.34248118	1.02711096
146	3.0	0.25	2.0	0.5	0.2	G1	0.10950888	0.32589833	1.04959137	-0.60786498	-0.57771380	0.41026580	-0.05691503
147	3.0	0.25	2.0	0.5	0.4	G0	0.80227055	-0.73209944	4.31037456	-8.11307777	8.36541796	-4.78269891	1.15122407
148	3.0	0.25	2.0	0.5	0.4	G1	0.12462774	0.26354555	1.25995145	-0.98012874	-0.14612109	0.12520899	0.01935526
149	3.0	0.25	2.0	0.5	0.6	G0	0.86425911	-0.97184160	5.49129466	-10.61866537	11.86987237	-7.39683733	1.89273997
150	3.0	0.25	2.0	0.5	0.6	G1	0.15028472	0.15725437	1.76548451	-2.08354784	1.43967519	-1.05368838	0.34538588
151	3.0	0.25	2.0	0.5	0.8	G0	0.94182791	-1.30725335	7.49650607	-15.53197403	19.71263138	-13.37782410	3.48985165
152	3.0	0.25	2.0	0.5	0.8	G1	0.18009292	-0.00425009	2.79213916	-4.86126761	5.94651416	-4.34176318	1.15187011
153	3.0	0.5	2.0	1	0.2	G0	1.05692331	-0.64763028	2.18075084	-4.33113276	5.09102241	-3.23620945	0.85075945
154	3.0	0.5	2.0	1	0.2	G1	0.15361073	0.55381873	1.16360051	-2.35340495	2.06845223	-1.19651003	0.31515981
155	3.0	0.5	2.0	1	0.4	G0	1.03000587	-0.58583793	2.27735252	-4.80603608	5.81499462	-3.75339511	0.99421666
156	3.0	0.5	2.0	1	0.4	G1	0.15512631	0.50947299	1.41137325	-2.94000755	2.81104512	-1.68384765	0.44444245
157	3.0	0.5	2.0	1	0.6	G0	1.06831028	-0.65421942	2.80042630	-6.03981238	7.36977462	-4.77734799	1.26513920
158	3.0	0.5	2.0	1	0.6	G1	0.17538019	0.44264465	1.75042993	-3.66684871	3.69817778	-2.26158490	0.59608354
159	3.0	0.5	2.0	1	0.8	G0	1.14623619	-0.77990898	3.89030488	-8.85440938	11.51727521	-7.81682335	2.09760531

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
160	3.0	0.5	2.0	1	0.8	G1	0.20741204	0.36876211	2.29819951	-5.01318629	5.68059612	-3.67239417	0.95199350
161	3.0	1	2.0	2	0.2	G0	0.73893985	-0.36153751	0.84374928	-2.01107827	2.03381256	-1.19937661	0.43197870
162	3.0	1	2.0	2	0.2	G1	0.08990900	0.52830445	0.63469969	-1.25577130	-0.11270281	0.59435632	-0.08853163
163	3.0	1	2.0	2	0.4	G0	0.70027323	-0.20594310	0.62519669	-1.96685694	2.26172959	-1.46756787	0.52860203
164	3.0	1	2.0	2	0.4	G1	0.08460278	0.52636093	0.74863614	-1.62117104	0.42088639	0.19999855	0.02966032
165	3.0	1	2.0	2	0.6	G0	0.69041806	-0.10824948	0.48541548	-1.91714966	2.31523124	-1.52158256	0.54349382
166	3.0	1	2.0	2	0.6	G1	0.08654387	0.52170286	0.83728449	-1.85831576	0.70586965	0.03526035	0.06679794
167	3.0	1	2.0	2	0.8	G0	0.69812817	-0.01156125	0.35425731	-1.78032092	2.19948689	-1.47903281	0.54465936
168	3.0	1	2.0	2	0.8	G1	0.09241702	0.53373315	0.89007193	-1.98095282	0.86258506	-0.07587698	0.09665495
169	3.5	0.01563	2.5	0.03125	0.2	G0	0.18574437	3.15018097	-8.77186978	18.87605353	-24.03777697	15.81304660	-4.19810759
170	3.5	0.01563	2.5	0.03125	0.2	G1	0.00246222	0.25671508	2.04825804	-2.98959326	2.63045189	-1.92848464	0.62454836
171	3.5	0.01563	2.5	0.03125	0.4	G0	0.19163207	2.90066181	-8.06888584	19.14358407	-26.41514142	18.50073242	-5.18597690
172	3.5	0.01563	2.5	0.03125	0.4	G1	0.00240500	0.25913335	1.83515217	-2.08379209	1.31968633	-1.04394416	0.37790836
173	3.5	0.01563	2.5	0.03125	0.6	G0	0.19580008	2.62387752	-6.15230951	14.20486686	-18.92999634	12.80637848	-3.55332267
174	3.5	0.01563	2.5	0.03125	0.6	G1	0.00322398	0.22493999	2.03235305	-2.63525607	2.62605878	-2.25815357	0.73338106
175	3.5	0.01563	2.5	0.03125	0.8	G0	0.19799772	2.39687687	-4.17962527	8.56875947	-9.76721531	6.54509199	-2.25493436
176	3.5	0.01563	2.5	0.03125	0.8	G1	0.00486200	0.16150479	2.53734108	-4.25414280	5.49408017	-3.83899371	0.78153446
177	3.5	0.03125	2.5	0.0625	0.2	G0	0.24957626	2.42041145	-4.83089293	7.67167671	-7.41605945	3.62192557	-0.70244678
178	3.5	0.03125	2.5	0.0625	0.2	G1	0.01155410	0.24736827	2.07884817	-3.19027576	2.95380944	-2.11332537	0.65404091
179	3.5	0.03125	2.5	0.0625	0.4	G0	0.24795200	2.35843482	-5.67065073	12.82985522	-16.82068293	10.99245591	-2.86769459
180	3.5	0.03125	2.5	0.0625	0.4	G1	0.01060189	0.25884087	1.79288570	-2.19272275	1.84143951	-1.63656480	0.59334939
181	3.5	0.03125	2.5	0.0625	0.6	G0	0.25127897	2.13047149	-4.58219435	11.75290621	-16.75612745	11.67112357	-3.26843022
182	3.5	0.03125	2.5	0.0625	0.6	G1	0.01044835	0.24258284	1.77928014	-1.91723703	1.75598056	-1.78238043	0.63994521
183	3.5	0.03125	2.5	0.0625	0.8	G0	0.25751239	1.80322321	-2.12792938	5.39158330	-7.48719778	5.94495750	-2.27171937
184	3.5	0.03125	2.5	0.0625	0.8	G1	0.01184103	0.17867940	2.23289114	-3.22923329	4.01126222	-2.84635811	0.52918861
185	3.5	0.0625	2.5	0.125	0.2	G0	0.36850510	1.24468028	0.62343185	-5.79431829	10.28233088	-8.16589424	2.43737037
186	3.5	0.0625	2.5	0.125	0.2	G1	0.03170473	0.23113084	1.98803714	-2.85073900	2.27017044	-1.47964141	0.44436523
187	3.5	0.0625	2.5	0.125	0.4	G0	0.36471963	1.20080397	0.17182282	-3.39553644	7.10548285	-6.52240913	2.14481486

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
188	3.5	0.0625	2.5	0.125	0.4	G1	0.03212645	0.21243396	1.98332298	-2.88671170	2.90723016	-2.34425234	0.76318928
189	3.5	0.0625	2.5	0.125	0.6	G0	0.36368808	1.09021179	0.37816623	-2.17286856	4.85534048	-5.13722524	1.82934234
190	3.5	0.0625	2.5	0.125	0.6	G1	0.03124096	0.18615290	2.08011344	-3.15356639	4.03433577	-3.66241545	1.21604490
191	3.5	0.0625	2.5	0.125	0.8	G0	0.37209592	0.82235246	1.89783501	-4.76988810	7.95250703	-6.38000486	1.62544169
192	3.5	0.0625	2.5	0.125	0.8	G1	0.03202932	0.12059015	2.54052042	-4.58050823	6.81441423	-5.45236105	1.41828086
193	3.5	0.125	2.5	0.25	0.2	G0	0.55136419	-0.10319566	4.98078754	-13.51439198	17.68100914	-11.76584487	3.13598383
194	3.5	0.125	2.5	0.25	0.2	G1	0.06628731	0.19288357	1.83044025	-2.24770286	1.25307506	-0.66712360	0.20236123
195	3.5	0.125	2.5	0.25	0.4	G0	0.56083624	-0.18553289	5.22311577	-13.74819413	18.39464975	-12.67265242	3.46589373
196	3.5	0.125	2.5	0.25	0.4	G1	0.07496549	0.14607311	2.01439463	-2.67941880	2.08841478	-1.42314207	0.43786161
197	3.5	0.125	2.5	0.25	0.6	G0	0.57302228	-0.37492848	6.30086242	-16.22624878	22.88473758	-16.73762958	4.77289000
198	3.5	0.125	2.5	0.25	0.6	G1	0.07944522	0.07874044	2.43616744	-3.91527170	4.54887122	-3.59875326	1.09899657
199	3.5	0.125	2.5	0.25	0.8	G0	0.58905382	-0.63207467	8.05174868	-20.83655551	31.28514971	-23.57153648	6.62919724
200	3.5	0.125	2.5	0.25	0.8	G1	0.08305159	-0.02040335	3.22972660	-6.56261294	9.63005374	-7.52036084	2.05107441
201	3.5	0.25	2.5	0.5	0.2	G0	0.76413490	-0.62638371	3.90471122	-7.42263263	7.57389779	-4.24480553	1.00294576
202	3.5	0.25	2.5	0.5	0.2	G1	0.10599876	0.32438116	1.04717801	-0.60165246	-0.58601599	0.41707791	-0.05910793
203	3.5	0.25	2.5	0.5	0.4	G0	0.77501391	-0.69207773	4.24002750	-8.02495755	8.30890774	-4.77282371	1.15339069
204	3.5	0.25	2.5	0.5	0.4	G1	0.11861659	0.26105633	1.28420830	-1.04146465	-0.06283609	0.06702646	0.03532797
205	3.5	0.25	2.5	0.5	0.6	G0	0.81911305	-0.88058008	5.33616545	-10.48202814	11.87628181	-7.48349079	1.92886692
206	3.5	0.25	2.5	0.5	0.6	G1	0.13898290	0.16538022	1.78953265	-2.19103036	1.62300534	-1.19565079	0.38585345
207	3.5	0.25	2.5	0.5	0.8	G0	0.87349879	-1.12628558	7.10291512	-15.08176877	19.56348895	-13.47380618	3.54519177
208	3.5	0.25	2.5	0.5	0.8	G1	0.16166149	0.02638655	2.77512921	-4.96597026	6.22145516	-4.58353312	1.22295643
209	3.5	0.5	2.5	1	0.2	G0	1.03245179	-0.60118276	2.14099832	-4.35827983	5.18175394	-3.31272923	0.87313377
210	3.5	0.5	2.5	1	0.2	G1	0.14829719	0.55167870	1.20653427	-2.47245833	2.22621473	-1.30140078	0.34298383
211	3.5	0.5	2.5	1	0.4	G0	0.99853323	-0.50094591	2.15284674	-4.71431172	5.79555246	-3.76915568	1.00181116
212	3.5	0.5	2.5	1	0.4	G1	0.14885244	0.51061910	1.45839974	-3.07910253	2.99340840	-1.80194055	0.47499106
213	3.5	0.5	2.5	1	0.6	G0	1.02832218	-0.51691773	2.53831838	-5.71942167	7.11970498	-4.66409988	1.24173415
214	3.5	0.5	2.5	1	0.6	G1	0.16720062	0.45482140	1.77692457	-3.77924542	3.85449228	-2.36366589	0.62230465
215	3.5	0.5	2.5	1	0.8	G0	1.09423194	-0.57340456	3.46274005	-8.32679351	11.18178178	-7.73282663	2.09566418

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y=0 D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
216	3.5	0.5	2.5	1	0.8	G1	0.19647730	0.39309654	2.32621015	-5.20120940	6.00264354	-3.91584551	1.02095906
217	3.5	1	2.5	2	0.2	G0	0.72356831	-0.31279124	0.78402573	-2.01354416	2.11966870	-1.28812570	0.46177962
218	3.5	1	2.5	2	0.2	G1	0.08691723	0.52977602	0.66465242	-1.35662946	0.03553615	0.48529053	-0.05620886
219	3.5	1	2.5	2	0.4	G0	0.68018042	-0.12059639	0.45125390	-1.76982253	2.14344494	-1.44446533	0.53349821
220	3.5	1	2.5	2	0.4	G1	0.08102843	0.53204886	0.77001975	-1.71577639	0.57095731	0.08388834	0.06567224
221	3.5	1	2.5	2	0.6	G0	0.66823104	0.00541220	0.20332740	-1.49797073	1.93400254	-1.33197326	0.50513280
222	3.5	1	2.5	2	0.6	G1	0.08280423	0.53229936	0.84091586	-1.91529799	0.80389909	-0.04153128	0.09100255
223	3.5	1	2.5	2	0.8	G0	0.67469278	0.12662386	-0.01978738	-1.16520013	1.57296687	-1.12285340	0.45951356
224	3.5	1	2.5	2	0.8	G1	0.08879538	0.54806291	0.88314632	-2.01340814	0.91441189	-0.10690075	0.10409507
225	4.0	0.01563	3.0	0.03125	0.2	G0	0.18547202	3.11057541	-8.84961869	19.31092175	-24.89865950	16.58472942	-4.45324306
226	4.0	0.01563	3.0	0.03125	0.2	G1	0.00231744	0.25653048	2.00358637	-2.88820186	2.46035681	-1.77348613	0.57287067
227	4.0	0.01563	3.0	0.03125	0.4	G0	0.19098864	2.80414478	-7.70771254	17.97998444	-24.57862285	17.13602104	-4.79485400
228	4.0	0.01563	3.0	0.03125	0.4	G1	0.00237141	0.25019218	1.85558092	-2.21842890	1.51508682	-1.14974563	0.39772519
229	4.0	0.01563	3.0	0.03125	0.6	G0	0.19320826	2.53833454	-5.86362852	13.08755545	-16.95876972	11.21944971	-3.06664555
230	4.0	0.01563	3.0	0.03125	0.6	G1	0.00308904	0.21549052	2.06283601	-2.84701700	2.97321865	-2.49361910	0.79560766
231	4.0	0.01563	3.0	0.03125	0.8	G0	0.19358480	2.33602802	-4.09371829	7.98916585	-8.52968371	5.43576127	-1.88240519
232	4.0	0.01563	3.0	0.03125	0.8	G1	0.00459469	0.15420646	2.55444240	-4.45520056	5.84258612	-4.09496366	0.85887401
233	4.0	0.03125	3.0	0.0625	0.2	G0	0.24720794	2.39058440	-4.97206063	8.31310721	-8.52684236	4.50028898	-0.96307349
234	4.0	0.03125	3.0	0.0625	0.2	G1	0.01104962	0.24536366	2.03607144	-3.09059867	2.82096333	-2.01790069	0.62785216
235	4.0	0.03125	3.0	0.0625	0.4	G0	0.24443276	2.26923955	-5.39462809	12.22900154	-16.25933478	10.82282588	-2.87807936
236	4.0	0.03125	3.0	0.0625	0.4	G1	0.00992293	0.25094987	1.77654207	-2.13144122	1.66610430	-1.43974126	0.52213597
237	4.0	0.03125	3.0	0.0625	0.6	G0	0.24612768	2.01718660	-4.01109936	9.87294678	-13.91438147	9.66184472	-2.71950656
238	4.0	0.03125	3.0	0.0625	0.6	G1	0.00975417	0.22872222	1.82170098	-2.07507417	1.90570402	-1.80482311	0.62571451
239	4.0	0.03125	3.0	0.0625	0.8	G0	0.25009298	1.70482168	-1.56416146	3.14154727	-3.63764476	2.91321826	-1.35578968
240	4.0	0.03125	3.0	0.0625	0.8	G1	0.01108954	0.16234404	2.31556719	-3.58600383	4.52402492	-3.17716468	0.61669406
241	4.0	0.0625	3.0	0.125	0.2	G0	0.36277550	1.22559920	0.49574269	-5.29794905	9.53588326	-7.63948990	2.29370419
242	4.0	0.0625	3.0	0.125	0.2	G1	0.03057249	0.22676585	1.96147612	-2.79216221	2.21510359	-1.45307882	0.43923895
243	4.0	0.0625	3.0	0.125	0.4	G0	0.35409348	1.15893828	0.17753672	-3.14384392	6.43352428	-5.87781836	1.93448104

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Run ID	Y=O D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
244	4.0	0.0625	3.0	0.125	0.4	G1	0.02976098	0.20471449	1.96188699	-2.79881845	2.73607704	-2.19598497	0.71821198
245	4.0	0.0625	3.0	0.125	0.6	G0	0.34968652	1.04221725	0.52051592	-2.43679216	4.84955123	-4.84279262	1.67959935
246	4.0	0.0625	3.0	0.125	0.6	G1	0.02834809	0.17896644	2.06512803	-3.07741810	3.80744553	-3.41855825	1.13209867
247	4.0	0.0625	3.0	0.125	0.8	G0	0.35519756	0.77962283	2.14120992	-5.65851479	9.07486815	-6.95956287	1.72981997
248	4.0	0.0625	3.0	0.125	0.8	G1	0.02886281	0.11429980	2.53929746	-4.57907674	6.67500551	-5.24728190	1.34088624
249	4.0	0.125	3.0	0.25	0.2	G0	0.54177352	-0.10213025	4.88072715	-13.22156312	17.30795923	-11.53480075	3.07884946
250	4.0	0.125	3.0	0.25	0.2	G1	0.06449996	0.18964689	1.81571695	-2.21364041	1.22204752	-0.65309245	0.19976385
251	4.0	0.125	3.0	0.25	0.4	G0	0.54079908	-0.17648901	5.12303564	-13.42469163	17.90672733	-12.32102130	3.36812430
252	4.0	0.125	3.0	0.25	0.4	G1	0.07011886	0.14295812	2.00196106	-2.63475432	2.02565597	-1.38022522	0.42624880
253	4.0	0.125	3.0	0.25	0.6	G0	0.54350469	-0.33168719	6.10462593	-15.75053349	22.17055390	-16.19231802	4.61479065
254	4.0	0.125	3.0	0.25	0.6	G1	0.07187740	0.08373172	2.40136126	-3.83780770	4.43337335	-3.50723337	1.07174197
255	4.0	0.125	3.0	0.25	0.8	G0	0.55181384	-0.53934014	7.65816605	-19.97235724	30.02708130	-22.60088590	6.34229245
256	4.0	0.125	3.0	0.25	0.8	G1	0.07358329	-0.00384598	3.15059266	-6.40817384	9.40246086	-7.33480615	1.99450260
257	4.0	0.25	3.0	0.5	0.2	G0	0.74939836	-0.60493298	3.83632618	-7.29251246	7.43134603	-4.16173940	0.98290771
258	4.0	0.25	3.0	0.5	0.2	G1	0.10299474	0.32298465	1.04781609	-0.60217424	-0.58556896	0.41723555	-0.05925322
259	4.0	0.25	3.0	0.5	0.4	G0	0.75131941	-0.64891230	4.15899329	-7.92026252	8.22771948	-4.74071412	1.14821736
260	4.0	0.25	3.0	0.5	0.4	G1	0.11340225	0.26070481	1.30269802	-1.09216526	0.00416316	0.02244605	0.04706407
261	4.0	0.25	3.0	0.5	0.6	G0	0.78160765	-0.78837376	5.15041476	-10.28125229	11.79003016	-7.49468625	1.94183216
262	4.0	0.25	3.0	0.5	0.6	G1	0.12959521	0.17580348	1.79987403	-2.27156029	1.76480768	-1.30228818	0.41526211
263	4.0	0.25	3.0	0.5	0.8	G0	0.81980253	-0.96194683	6.70481863	-14.60343245	19.34211000	-13.49674860	3.57803899
264	4.0	0.25	3.0	0.5	0.8	G1	0.14721391	0.05441856	2.75321870	-5.06351305	6.47533879	-4.80121150	1.28650018
265	4.0	0.5	3.0	1	0.2	G0	1.01106016	-0.55582600	2.09455307	-4.37033540	5.25959527	-3.38477541	0.89525243
266	4.0	0.5	3.0	1	0.2	G1	0.14382446	0.54992803	1.24611689	-2.58598364	2.38048395	-1.40598248	0.37117542
267	4.0	0.5	3.0	1	0.4	G0	0.97163756	-0.41615792	1.99461271	-4.52898819	5.65381846	-3.70434247	0.98822656
268	4.0	0.5	3.0	1	0.4	G1	0.14356014	0.51453846	1.48618203	-3.17152295	3.11566908	-1.88007622	0.49491435
269	4.0	0.5	3.0	1	0.6	G0	0.99407486	-0.38242238	2.22939681	-5.26288565	6.68473543	-4.42281004	1.18281181
270	4.0	0.5	3.0	1	0.6	G1	0.16004858	0.47045164	1.77601739	-3.82553545	3.92263884	-2.40303694	0.63049783
271	4.0	0.5	3.0	1	0.8	G0	1.04965946	-0.37649930	2.97623553	-7.60406922	10.55614860	-7.43201387	2.02991545

Run ID	Y=O D/ID	a/l=a/2c	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
272	4.0	0.5	3.0	1	0.8	G1	0.18671177	0.42032128	2.32014466	-5.30583087	6.20806863	-4.06964728	1.06198086
273	4.0	1	3.0	2	0.2	G0	0.70976587	-0.26512065	0.71415616	-1.98525344	2.16630063	-1.35230980	0.48543784
274	4.0	1	3.0	2	0.2	G1	0.08430153	0.53166680	0.68935487	-1.44463617	0.16849387	0.38559211	-0.02625232
275	4.0	1	3.0	2	0.4	G0	0.66306661	-0.04024268	0.26403041	-1.51418583	1.93652847	-1.35805934	0.52066198
276	4.0	1	3.0	2	0.4	G1	0.07805148	0.53845109	0.77972475	-1.77666632	0.67350468	0.00184712	0.09187597
277	4.0	1	3.0	2	0.6	G0	0.64984582	0.10724535	-0.07173200	-1.06005634	1.50987787	-1.10498075	0.45443914
278	4.0	1	3.0	2	0.6	G1	0.07975309	0.54215598	0.83883493	-1.95400134	0.87344176	-0.09403284	0.10681434
279	4.0	1	3.0	2	0.8	G0	0.65538852	0.24627846	-0.36277048	-0.58966363	0.98319725	-0.78189929	0.37501580
280	4.0	1	3.0	2	0.8	G1	0.08582457	0.55957513	0.88219374	-2.06452611	0.99344416	-0.15157658	0.11252735

APPENDIX B - AXIAL INTERNAL FULL-WIDTH CRACK RESULTS

The internal 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 2. Non-dimensional Geometry Polynomial Coefficient Values for Axial Internal Full-Width Cracks

Run ID	$Y=OD/ID$	t/R_i	a/t	G_i	$A0$
301	2	1	0.2	$G0$	1.15882634
302	2	1	0.2	$G1$	0.69868014
303	2	1	0.2	$G2$	0.53489320
304	2	1	0.2	$G3$	0.44740833
305	2	1	0.2	$G4$	0.39156371
306	2	1	0.4	$G0$	1.32423266
307	2	1	0.4	$G1$	0.76305588
308	2	1	0.4	$G2$	0.57118634
309	2	1	0.4	$G3$	0.47143448
310	2	1	0.4	$G4$	0.40897512
311	2	1	0.6	$G0$	1.55252331
312	2	1	0.6	$G1$	0.85639239
313	2	1	0.6	$G2$	0.62541133
314	2	1	0.6	$G3$	0.50804517
315	2	1	0.6	$G4$	0.43587232
316	2	1	0.8	$G0$	1.93730719
317	2	1	0.8	$G1$	1.03909236
318	2	1	0.8	$G2$	0.74025823
319	2	1	0.8	$G3$	0.58944872
320	2	1	0.8	$G4$	0.49768814
321	2.5	1.5	0.2	$G0$	1.09593519
322	2.5	1.5	0.2	$G1$	0.67419243
323	2.5	1.5	0.2	$G2$	0.52113179
324	2.5	1.5	0.2	$G3$	0.43834312
325	2.5	1.5	0.2	$G4$	0.38503308
326	2.5	1.5	0.4	$G0$	1.19544059
327	2.5	1.5	0.4	$G1$	0.71429548
328	2.5	1.5	0.4	$G2$	0.54424695
329	2.5	1.5	0.4	$G3$	0.45388079
330	2.5	1.5	0.4	$G4$	0.39641962
331	2.5	1.5	0.6	$G0$	1.36393029
332	2.5	1.5	0.6	$G1$	0.78760630
333	2.5	1.5	0.6	$G2$	0.58828799
334	2.5	1.5	0.6	$G3$	0.48424064
335	2.5	1.5	0.6	$G4$	0.41904421

Run ID	Y=OD/ID	t/Ri	a/t	Gi	A0
336	2.5	1.5	0.8	G0	1.71240592
337	2.5	1.5	0.8	G1	0.96005231
338	2.5	1.5	0.8	G2	0.69871611
339	2.5	1.5	0.8	G3	0.56334099
340	2.5	1.5	0.8	G4	0.47952416
341	3	2	0.2	G0	1.05018068
342	3	2	0.2	G1	0.65645208
343	3	2	0.2	G2	0.51118837
344	3	2	0.2	G3	0.43180494
345	3	2	0.2	G4	0.38032975
346	3	2	0.4	G0	1.11779278
347	3	2	0.4	G1	0.68499905
348	3	2	0.4	G2	0.52808078
349	3	2	0.4	G3	0.44334898
350	3	2	0.4	G4	0.38888522
351	3	2	0.6	G0	1.26093582
352	3	2	0.6	G1	0.75002553
353	3	2	0.6	G2	0.56795810
354	3	2	0.6	G3	0.47116591
355	3	2	0.6	G4	0.40977426
356	3	2	0.8	G0	1.58927277
357	3	2	0.8	G1	0.91617522
358	3	2	0.8	G2	0.67535141
359	3	2	0.8	G3	0.54848142
360	3	2	0.8	G4	0.46907504
361	3.5	2.5	0.2	G0	1.01577656
362	3.5	2.5	0.2	G1	0.64317328
363	3.5	2.5	0.2	G2	0.50376596
364	3.5	2.5	0.2	G3	0.42693326
365	3.5	2.5	0.2	G4	0.37683003
366	3.5	2.5	0.4	G0	1.06625956
367	3.5	2.5	0.4	G1	0.66561388
368	3.5	2.5	0.4	G2	0.51739048
369	3.5	2.5	0.4	G3	0.43638145
370	3.5	2.5	0.4	G4	0.38389647
371	3.5	2.5	0.6	G0	1.19549755
372	3.5	2.5	0.6	G1	0.72606187
373	3.5	2.5	0.6	G2	0.55492386
374	3.5	2.5	0.6	G3	0.46273275
375	3.5	2.5	0.6	G4	0.40375957
376	3.5	2.5	0.8	G0	1.50884203
377	3.5	2.5	0.8	G1	0.88698032
378	3.5	2.5	0.8	G2	0.65954197
379	3.5	2.5	0.8	G3	0.53827347

Run ID	$Y=OD/ID$	t/R_i	a/t	G_i	A_0
380	3.5	2.5	0.8	G4	0.46179802
381	4	3	0.2	G0	0.98909403
382	4	3	0.2	G1	0.63292257
383	4	3	0.2	G2	0.49805153
384	4	3	0.2	G3	0.42318881
385	4	3	0.2	G4	0.37414319
386	4	3	0.4	G0	1.02953006
387	4	3	0.4	G1	0.65182489
388	4	3	0.4	G2	0.50978292
389	4	3	0.4	G3	0.43141548
390	4	3	0.4	G4	0.38033383
391	4	3	0.6	G0	1.14957244
392	4	3	0.6	G1	0.70911352
393	4	3	0.6	G2	0.54562022
394	4	3	0.6	G3	0.45665577
395	4	3	0.6	G4	0.39938500
396	4	3	0.8	G0	1.45083851
397	4	3	0.8	G1	0.86553019
398	4	3	0.8	G2	0.64773533
399	4	3	0.8	G3	0.53053936
400	4	3	0.8	G4	0.45621310

APPENDIX C - CIRCUMFERENTIAL INTERNAL 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 3. Non-Dimensional Geometry Polynomial Coefficient Values for Circumferential Internal Surface Cracks

Run ID	Y = OD/ID	$a/l = a/(2*c)$	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
501	2	0.015625	1	0.03125	0.2	G0	too long						
502	2	0.015625	1	0.03125	0.2	G1	too long						
503	2	0.015625	1	0.03125	0.2	G5	too long						
504	2	0.015625	1	0.03125	0.2	G6	too long						
505	2	0.015625	1	0.03125	0.4	G0	too long						
506	2	0.015625	1	0.03125	0.4	G1	too long						
507	2	0.015625	1	0.03125	0.4	G5	too long						
508	2	0.015625	1	0.03125	0.4	G6	too long						
509	2	0.015625	1	0.03125	0.6	G0	too long						
510	2	0.015625	1	0.03125	0.6	G1	too long						
511	2	0.015625	1	0.03125	0.6	G5	too long						
512	2	0.015625	1	0.03125	0.6	G6	too long						
513	2	0.015625	1	0.03125	0.8	G0	too long						
514	2	0.015625	1	0.03125	0.8	G1	too long						
515	2	0.015625	1	0.03125	0.8	G5	too long						
516	2	0.015625	1	0.03125	0.8	G6	too long						
517	2	0.03125	1	0.0625	0.2	G0	too long						
518	2	0.03125	1	0.0625	0.2	G1	too long						
519	2	0.03125	1	0.0625	0.2	G5	too long						
520	2	0.03125	1	0.0625	0.2	G6	too long						
521	2	0.03125	1	0.0625	0.4	G0	too long						

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
522	2	0.03125	1	0.0625	0.4	G1	too long						
523	2	0.03125	1	0.0625	0.4	G5	too long						
524	2	0.03125	1	0.0625	0.4	G6	too long						
525	2	0.03125	1	0.0625	0.6	G0	too long						
526	2	0.03125	1	0.0625	0.6	G1	too long						
527	2	0.03125	1	0.0625	0.6	G5	too long						
528	2	0.03125	1	0.0625	0.6	G6	too long						
529	2	0.03125	1	0.0625	0.8	G0	too long						
530	2	0.03125	1	0.0625	0.8	G1	too long						
531	2	0.03125	1	0.0625	0.8	G5	too long						
532	2	0.03125	1	0.0625	0.8	G6	too long						
533	2	0.0625	1	0.125	0.2	G0	0.19649274	3.37733430	-9.04160150	17.69306300	-20.69529400	12.69972600	-3.18510930
534	2	0.0625	1	0.125	0.2	G1	-0.00074471	0.49819628	0.98011019	-0.50201097	-0.65581682	0.34714344	-0.01059897
535	2	0.0625	1	0.125	0.2	G5	0.05076255	-0.41471368	2.18877769	-2.80158448	5.16759968	-5.45534182	1.83888936
536	2	0.0625	1	0.125	0.2	G6	-0.06548428	-1.99423277	5.26439524	-9.59685135	10.54757500	-4.29201365	0.13440895
537	2	0.0625	1	0.125	0.4	G0	too long						
538	2	0.0625	1	0.125	0.4	G1	too long						
539	2	0.0625	1	0.125	0.4	G5	too long						
540	2	0.0625	1	0.125	0.4	G6	too long						
541	2	0.0625	1	0.125	0.6	G0	too long						
542	2	0.0625	1	0.125	0.6	G1	too long						
543	2	0.0625	1	0.125	0.6	G5	too long						
544	2	0.0625	1	0.125	0.6	G6	too long						
545	2	0.0625	1	0.125	0.8	G0	too long						
546	2	0.0625	1	0.125	0.8	G1	too long						
547	2	0.0625	1	0.125	0.8	G5	too long						
548	2	0.0625	1	0.125	0.8	G6	too long						
549	2	0.125	1	0.25	0.2	G0	0.55321667	0.00499976	5.04611220	-13.89330800	18.38340300	-12.42087500	3.36444610

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
550	2	0.125	1	0.25	0.2	G1	0.06601916	0.14320361	2.27338590	-3.37082090	2.88318110	-1.90879140	0.57335766
551	2	0.125	1	0.25	0.2	G5	0.22125046	0.01275979	1.70743024	-2.97587609	3.08260393	-1.98212373	0.51110494
552	2	0.125	1	0.25	0.2	G6	-0.16802326	-0.20809902	-0.39143783	1.22647643	0.06445879	-0.85528576	0.33176917
553	2	0.125	1	0.25	0.4	G0	0.55428525	-0.03257189	5.19051830	-14.13169900	18.82193900	-12.85158100	3.50854280
554	2	0.125	1	0.25	0.4	G1	0.06993267	0.11431817	2.39582300	-3.64446480	3.33784250	-2.29695680	0.69476067
555	2	0.125	1	0.25	0.4	G5	0.05541613	-0.08763640	0.98594451	-0.74947619	3.77270913	-5.32121086	1.98037887
556	2	0.125	1	0.25	0.4	G6	-0.25582391	-0.24717997	-1.16426694	1.62267137	1.07896447	-1.03807724	0.00359404
557	2	0.125	1	0.25	0.6	G0	0.61588512	-0.70013620	8.82797100	-23.71499500	32.86583100	-23.05300900	6.34053650
558	2	0.125	1	0.25	0.6	G1	0.08274508	0.05150389	2.70040460	-4.43783820	4.80338330	-3.48679590	1.01390600
559	2	0.125	1	0.25	0.6	G5	-0.13358672	-0.14164990	0.03646374	-1.60219097	13.34926320	-16.08569530	5.30606604
560	2	0.125	1	0.25	0.6	G6	-0.23288402	0.04200742	-2.42181110	2.44174027	-3.16710281	7.50414705	-4.16763163
561	2	0.125	1	0.25	0.8	G0	too long						
562	2	0.125	1	0.25	0.8	G1	too long						
563	2	0.125	1	0.25	0.8	G5	too long						
564	2	0.125	1	0.25	0.8	G6	too long						
565	2	0.25	1	0.5	0.2	G0	0.85881481	-1.15056840	6.29662000	-12.68848900	14.14480000	-8.61031830	2.18547720
566	2	0.25	1	0.5	0.2	G1	0.12563289	0.25876498	1.26694950	-0.86615338	-0.30934566	0.19078773	0.01502248
567	2	0.25	1	0.5	0.2	G5	0.41677868	-0.46341327	2.63733959	-4.31297112	3.75420403	-1.79655230	0.34687549
568	2	0.25	1	0.5	0.2	G6	-0.13245851	0.17288898	-0.97940302	2.47610712	-2.87156105	1.87285531	-0.53847873
569	2	0.25	1	0.5	0.4	G0	0.88051950	-1.40166200	7.16675310	-13.92566700	15.01166100	-8.89328100	2.21395210
570	2	0.25	1	0.5	0.4	G1	0.13480417	0.20574039	1.30394130	-0.58617056	-0.86440987	0.58551975	-0.08730737
571	2	0.25	1	0.5	0.4	G5	0.37010863	-0.44175080	2.35250902	-2.55272770	1.20839095	-0.23571736	-0.04787424
572	2	0.25	1	0.5	0.4	G6	-0.25180075	0.25236878	-1.27133942	1.71472728	0.41308653	-1.30927885	0.45207837
573	2	0.25	1	0.5	0.6	G0	0.92243052	-1.66348930	8.29401380	-15.79819800	16.79460400	-9.80128910	2.38512600
574	2	0.25	1	0.5	0.6	G1	0.15343450	0.12752278	1.53103740	-0.73722549	-0.85833197	0.63322401	-0.11881369
575	2	0.25	1	0.5	0.6	G5	0.29522789	-0.43427217	2.32641625	-2.44894719	2.88631439	-2.77088642	0.90281934
576	2	0.25	1	0.5	0.6	G6	-0.35251528	0.40962321	-2.26963449	2.84874582	0.52551568	-1.59893095	0.43711805
577	2	0.25	1	0.5	0.8	G0	1.01731240	-2.16607470	10.86521700	-21.77887500	25.30667400	-15.49565900	3.66635520

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
578	2	0.25	1	0.5	0.8	G1	0.19397957	-0.05496712	2.39876610	-2.71204760	2.01307120	-1.11127120	0.14427680
579	2	0.25	1	0.5	0.8	G5	0.21550036	-0.47345656	2.34733653	-2.97424316	6.63729382	-6.72655821	1.95150518
580	2	0.25	1	0.5	0.8	G6	-0.42708507	0.58638257	-3.47327685	4.55162239	-1.63083088	1.27090025	-0.87773633
581	2	0.5	1	1	0.2	G0	1.18516770	-1.09929630	3.18058390	-5.67853190	6.80507320	-4.64985730	1.30315780
582	2	0.5	1	1	0.2	G1	0.18548478	0.54220433	0.85646416	-1.55484840	1.55525160	-1.23029830	0.39031056
583	2	0.5	1	1	0.2	G5	0.60149241	-0.44069922	1.24031258	-1.38515496	0.73684633	-0.09635632	-0.06107924
584	2	0.5	1	1	0.2	G6	-0.07669394	0.07709739	-0.25231397	0.58493042	-0.58525288	0.39052314	-0.13793841
585	2	0.5	1	1	0.4	G0	1.21641530	-1.40283950	4.12793150	-7.27444410	8.99830410	-6.51551690	1.93076470
586	2	0.5	1	1	0.4	G1	0.19981964	0.45843849	1.04207670	-2.04946030	2.85122360	-2.62584890	0.89004787
587	2	0.5	1	1	0.4	G5	0.61719823	-0.53129077	1.74985409	-2.20923209	2.08585715	-1.44844139	0.42557576
588	2	0.5	1	1	0.4	G6	-0.15915775	0.15577149	-0.73802626	2.29646277	-3.39995623	2.73681259	-0.89152199
589	2	0.5	1	1	0.6	G0	1.26592160	-1.66174680	4.69281960	-7.27967080	8.25366830	-5.92317000	1.79208590
590	2	0.5	1	1	0.6	G1	0.22172688	0.38638722	1.06139540	-1.74190170	2.61421380	-2.73543880	0.99215332
591	2	0.5	1	1	0.6	G5	0.63152319	-0.61328870	2.07570505	-2.23096228	2.17216492	-1.87390351	0.63966829
592	2	0.5	1	1	0.6	G6	-0.23835558	0.19012679	-0.71080625	0.84017789	0.81346309	-1.40442944	0.51039743
593	2	0.5	1	1	0.8	G0	1.35634050	-1.98396540	5.56454560	-7.61133130	7.60329000	-4.98711580	1.37135860
594	2	0.5	1	1	0.8	G1	0.26132523	0.28076494	1.24597870	-1.60941020	2.36474720	-2.48488640	0.83742341
595	2	0.5	1	1	0.8	G5	0.65977752	-0.74442267	2.55064344	-2.35186934	2.43933678	-2.27869701	0.72055477
596	2	0.5	1	1	0.8	G6	-0.31731346	0.17899653	-0.73247898	0.85855752	0.22045177	0.07285667	-0.28134304
597	2	1	1	2	0.2	G0	0.81915040	-0.59310586	1.09038750	-1.83535670	1.27315870	-0.14389109	-0.07501270
598	2	1	1	2	0.2	G1	0.10968072	0.54623183	0.30486184	-0.28256785	-1.66949530	2.15351230	-0.73308185
599	2	1	1	2	0.2	G5	0.41764531	-0.21887805	0.38630128	-0.25046086	-0.75132233	1.16886055	-0.44143927
600	2	1	1	2	0.2	G6	-0.02251883	0.02624558	-0.12124907	0.39920595	-0.56780356	0.42017520	-0.13190424
601	2	1	1	2	0.4	G0	0.83949460	-0.72978530	1.70202020	-3.55557680	4.14237130	-2.36067920	0.53882358
602	2	1	1	2	0.4	G1	0.11907706	0.51324353	0.46429587	-0.98788437	-0.22999952	1.03551600	-0.45693894
603	2	1	1	2	0.4	G5	0.43741685	-0.22982952	0.67602104	-0.97041631	0.26317269	0.49755415	-0.29393828
604	2	1	1	2	0.4	G6	-0.04719056	0.03762180	-0.19999835	0.63549972	-0.80068481	0.52885646	-0.15264195
605	2	1	1	2	0.6	G0	0.86471586	-0.85887187	2.24853930	-5.24316230	7.35775120	-5.20566090	1.45150700

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
606	2	1	1	2	0.6	G1	0.13068870	0.47217210	0.68537243	-2.00091070	1.96072590	-0.91294547	0.14656567
607	2	1	1	2	0.6	G5	0.45951390	-0.24277386	0.94987589	-1.78823149	1.80029333	-0.85936081	0.13243902
608	2	1	1	2	0.6	G6	-0.07267569	0.04314246	-0.36132285	1.35313988	-2.05338669	1.58623886	-0.49394289
609	2	1	1	2	0.8	G0	0.89870316	-0.97364907	2.66944620	-6.09382470	8.74622800	-6.34588290	1.77908220
610	2	1	1	2	0.8	G1	0.14527745	0.44413317	0.81731916	-2.51776720	3.15492960	-1.96597090	0.44589195
611	2	1	1	2	0.8	G5	0.48706251	-0.26633135	1.28075337	-2.57808161	3.14412737	-1.96139956	0.44227570
612	2	1	1	2	0.8	G6	-0.09846215	0.04187309	-0.56564039	2.13592911	-3.16677308	2.34448934	-0.68988210
613	2.5	0.015625	1.5	0.03125	0.2	G0	too long						
614	2.5	0.015625	1.5	0.03125	0.2	G1	too long						
615	2.5	0.015625	1.5	0.03125	0.2	G5	too long						
616	2.5	0.015625	1.5	0.03125	0.2	G6	too long						
617	2.5	0.015625	1.5	0.03125	0.4	G0	too long						
618	2.5	0.015625	1.5	0.03125	0.4	G1	too long						
619	2.5	0.015625	1.5	0.03125	0.4	G5	too long						
620	2.5	0.015625	1.5	0.03125	0.4	G6	too long						
621	2.5	0.015625	1.5	0.03125	0.6	G0	too long						
622	2.5	0.015625	1.5	0.03125	0.6	G1	too long						
623	2.5	0.015625	1.5	0.03125	0.6	G5	too long						
624	2.5	0.015625	1.5	0.03125	0.6	G6	too long						
625	2.5	0.015625	1.5	0.03125	0.8	G0	too long						
626	2.5	0.015625	1.5	0.03125	0.8	G1	too long						
627	2.5	0.015625	1.5	0.03125	0.8	G5	too long						
628	2.5	0.015625	1.5	0.03125	0.8	G6	too long						
629	2.5	0.03125	1.5	0.0625	0.2	G0	too long						
630	2.5	0.03125	1.5	0.0625	0.2	G1	too long						
631	2.5	0.03125	1.5	0.0625	0.2	G5	too long						
632	2.5	0.03125	1.5	0.0625	0.2	G6	too long						
633	2.5	0.03125	1.5	0.0625	0.4	G0	too long						

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
634	2.5	0.03125	1.5	0.0625	0.4	G1	too long						
635	2.5	0.03125	1.5	0.0625	0.4	G5	too long						
636	2.5	0.03125	1.5	0.0625	0.4	G6	too long						
637	2.5	0.03125	1.5	0.0625	0.6	G0	too long						
638	2.5	0.03125	1.5	0.0625	0.6	G1	too long						
639	2.5	0.03125	1.5	0.0625	0.6	G5	too long						
640	2.5	0.03125	1.5	0.0625	0.6	G6	too long						
641	2.5	0.03125	1.5	0.0625	0.8	G0	too long						
642	2.5	0.03125	1.5	0.0625	0.8	G1	too long						
643	2.5	0.03125	1.5	0.0625	0.8	G5	too long						
644	2.5	0.03125	1.5	0.0625	0.8	G6	too long						
645	2.5	0.0625	1.5	0.125	0.2	G0	0.18774621	3.36661390	-9.17856760	17.90060600	-20.87349600	12.81374200	-3.21761250
646	2.5	0.0625	1.5	0.125	0.2	G1	-0.00177250	0.48884315	0.98141629	-0.56663947	-0.56909283	0.31730001	-0.01010059
647	2.5	0.0625	1.5	0.125	0.2	G5	-0.00046244	-1.46455455	5.20950079	-10.57657810	18.10288430	-15.15783600	4.34301901
648	2.5	0.0625	1.5	0.125	0.2	G6	-0.00392442	-1.52984464	4.47631550	-10.66211990	11.01471900	-1.82530320	-1.47247553
649	2.5	0.0625	1.5	0.125	0.4	G0	too long						
650	2.5	0.0625	1.5	0.125	0.4	G1	too long						
651	2.5	0.0625	1.5	0.125	0.4	G5	too long						
652	2.5	0.0625	1.5	0.125	0.4	G6	too long						
653	2.5	0.0625	1.5	0.125	0.6	G0	too long						
654	2.5	0.0625	1.5	0.125	0.6	G1	too long						
655	2.5	0.0625	1.5	0.125	0.6	G5	too long						
656	2.5	0.0625	1.5	0.125	0.6	G6	too long						
657	2.5	0.0625	1.5	0.125	0.8	G0	too long						
658	2.5	0.0625	1.5	0.125	0.8	G1	too long						
659	2.5	0.0625	1.5	0.125	0.8	G5	too long						
660	2.5	0.0625	1.5	0.125	0.8	G6	too long						
661	2.5	0.125	1.5	0.25	0.2	G0	0.53725990	-0.00953219	4.98940410	-13.79002000	18.28857100	-12.36156100	3.34792630

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
662	2.5	0.125	1.5	0.25	0.2	G1	0.06228560	0.13551549	2.25323240	-3.32146210	2.81907070	-1.86011960	0.55885482
663	2.5	0.125	1.5	0.25	0.2	G5	0.11214997	-0.02551663	1.06219792	-1.26913059	1.96823907	-2.12050009	0.73902094
664	2.5	0.125	1.5	0.25	0.2	G6	-0.17763962	-0.19045973	-0.68984467	1.58166003	-0.06302226	-0.65573961	0.19501855
665	2.5	0.125	1.5	0.25	0.4	G0	0.53351433	-0.13574455	5.68861460	-15.84655100	21.56682100	-14.87986200	4.07827860
666	2.5	0.125	1.5	0.25	0.4	G1	0.06589056	0.07850637	2.52063940	-4.05949540	3.99749590	-2.77419610	0.82467923
667	2.5	0.125	1.5	0.25	0.4	G5	-0.09609125	-0.26808685	0.59711313	-2.31416273	11.21741100	-12.80532260	4.18690157
668	2.5	0.125	1.5	0.25	0.4	G6	-0.15326022	-0.19383532	-0.76894224	-0.72907066	1.09147525	3.20764351	-2.45511961
669	2.5	0.125	1.5	0.25	0.6	G0	too long						
670	2.5	0.125	1.5	0.25	0.6	G1	too long						
671	2.5	0.125	1.5	0.25	0.6	G5	too long						
672	2.5	0.125	1.5	0.25	0.6	G6	too long						
673	2.5	0.125	1.5	0.25	0.8	G0	too long						
674	2.5	0.125	1.5	0.25	0.8	G1	too long						
675	2.5	0.125	1.5	0.25	0.8	G5	too long						
676	2.5	0.125	1.5	0.25	0.8	G6	too long						
677	2.5	0.25	1.5	0.5	0.2	G0	0.84361568	-1.21867180	6.47493220	-12.77243700	13.92032700	-8.30750330	2.07650060
678	2.5	0.25	1.5	0.5	0.2	G1	0.12162194	0.24869525	1.20728880	-0.56920620	-0.77822464	0.51976044	-0.07350034
679	2.5	0.25	1.5	0.5	0.2	G5	0.30777779	-0.34701511	1.95274186	-2.68839002	1.86615193	-0.68546367	0.07556582
680	2.5	0.25	1.5	0.5	0.2	G6	-0.15405028	0.21293604	-1.12971926	1.95219326	-0.57356334	-0.73727322	0.42987692
681	2.5	0.25	1.5	0.5	0.4	G0	0.84746040	-1.50397000	7.58804270	-14.53309400	15.31691200	-8.83452030	2.14118250
682	2.5	0.25	1.5	0.5	0.4	G1	0.12595639	0.18975397	1.23767010	-0.16540008	-1.59212570	1.13197620	-0.24346957
683	2.5	0.25	1.5	0.5	0.4	G5	0.20486668	-0.28251952	1.59643698	-1.60430396	2.04592085	-2.14378953	0.73802465
684	2.5	0.25	1.5	0.5	0.4	G6	-0.27243036	0.30789793	-1.75319588	2.22510290	0.36087656	-1.17788196	0.30949572
685	2.5	0.25	1.5	0.5	0.6	G0	0.87922837	-1.85594590	9.39470260	-18.55239200	20.55481700	-12.35889400	3.05183180
686	2.5	0.25	1.5	0.5	0.6	G1	0.14243915	0.08262551	1.62546500	-0.76876212	-0.84684983	0.61428756	-0.11932603
687	2.5	0.25	1.5	0.5	0.6	G5	0.06435868	-0.19544724	1.03749871	-1.69483304	6.86317444	-8.22262287	2.80726099
688	2.5	0.25	1.5	0.5	0.6	G6	-0.32937259	0.45423812	-2.63216710	2.18869305	1.48308313	-0.86729991	-0.29734308
689	2.5	0.25	1.5	0.5	0.8	G0	0.96912906	-2.52904450	13.10681300	-28.69528600	36.30705400	-23.38937600	5.67862190

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
690	2.5	0.25	1.5	0.5	0.8	G1	0.18161513	-0.16621665	2.88163310	-4.16527970	4.55552420	-2.95583910	0.56801657
691	2.5	0.25	1.5	0.5	0.8	G5	-0.06931113	-0.18537630	0.82250035	-4.96696138	18.15073200	-17.92926600	5.05257797
692	2.5	0.25	1.5	0.5	0.8	G6	-0.31219241	0.56357229	-3.57192612	4.60710382	-7.80544138	12.44617940	-5.92781258
693	2.5	0.5	1.5	1	0.2	G0	1.17677920	-1.17929860	3.38624030	-6.03012980	7.68418750	-5.71644980	1.72951980
694	2.5	0.5	1.5	1	0.2	G1	0.18501752	0.51642840	0.92509988	-1.91961450	2.62445090	-2.39270580	0.81184730
695	2.5	0.5	1.5	1	0.2	G5	0.47719061	-0.35497195	1.06299806	-1.17842841	0.88260925	-0.52314055	0.14063437
696	2.5	0.5	1.5	1	0.2	G6	-0.09347811	0.08592588	-0.32293838	1.03664601	-1.70330453	1.57560635	-0.57866705
697	2.5	0.5	1.5	1	0.4	G0	1.19466860	-1.50815640	4.20745520	-6.30323540	6.95405300	-4.97251940	1.51343590
698	2.5	0.5	1.5	1	0.4	G1	0.19671192	0.43612210	0.89947740	-1.43452620	2.21129960	-2.44565410	0.91112676
699	2.5	0.5	1.5	1	0.4	G5	0.47147620	-0.42652062	1.50146580	-1.59222198	1.59820926	-1.44610322	0.50685233
700	2.5	0.5	1.5	1	0.4	G6	-0.18821560	0.15177707	-0.58453751	0.70426452	0.64889395	-1.16349757	0.43178517
701	2.5	0.5	1.5	1	0.6	G0	1.23420040	-1.79243690	4.85039980	-5.93563920	5.11904510	-3.35834820	1.04122690
702	2.5	0.5	1.5	1	0.6	G1	0.21815877	0.35588956	0.84329829	-0.61892699	1.06002330	-1.85897380	0.81490247
703	2.5	0.5	1.5	1	0.6	G5	0.45345756	-0.51050967	1.95138848	-2.22503948	3.37519145	-3.62899947	1.32539022
704	2.5	0.5	1.5	1	0.6	G6	-0.27888751	0.19419462	-1.08591950	1.99827409	-1.51623893	1.30962765	-0.62120831
705	2.5	0.5	1.5	1	0.8	G0	1.33568760	-2.23831640	6.19174340	-6.74290970	4.50202220	-1.98038830	0.32779888
706	2.5	0.5	1.5	1	0.8	G1	0.26759258	0.19344782	1.12892810	-0.28916696	0.18530310	-0.92997055	0.38680086
707	2.5	0.5	1.5	1	0.8	G5	0.44671473	-0.66049057	2.28013849	-1.84060371	3.42279601	-3.97891355	1.30041695
708	2.5	0.5	1.5	1	0.8	G6	-0.36094892	0.17584641	-0.94390053	0.13547128	1.97124314	-0.58385783	-0.39426357
709	2.5	1	1.5	2	0.2	G0	0.82060851	-0.62609736	1.21717410	-2.14946380	1.81040540	-0.52031648	0.00035669
710	2.5	1	1.5	2	0.2	G1	0.11174871	0.53887177	0.33736972	-0.48043962	-1.24014070	1.86105380	-0.68690628
711	2.5	1	1.5	2	0.2	G5	0.33763194	-0.17031381	0.41946834	-0.54702246	-0.03443527	0.50303352	-0.23459953
712	2.5	1	1.5	2	0.2	G6	-0.02755898	0.02655404	-0.13439566	0.44467759	-0.61952704	0.45435602	-0.14238560
713	2.5	1	1.5	2	0.4	G0	0.84159689	-0.80297612	2.06440610	-4.76109110	6.58115470	-4.56734090	1.24761560
714	2.5	1	1.5	2	0.4	G1	0.12325645	0.48685499	0.63036056	-1.85572290	1.71838490	-0.70690303	0.07957894
715	2.5	1	1.5	2	0.4	G5	0.35625681	-0.17290640	0.71555662	-1.36384618	1.35792446	-0.62331969	0.08532079
716	2.5	1	1.5	2	0.4	G6	-0.05788959	0.03537443	-0.30057275	1.14771938	-1.80093336	1.43363929	-0.45626363
717	2.5	1	1.5	2	0.6	G0	0.86751968	-0.93897585	2.46703010	-5.59421300	8.21016040	-6.12900670	1.76827610

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
718	2.5	1	1.5	2	0.6	G1	0.13700908	0.44637736	0.73162281	-2.38873770	3.19847360	-2.17359890	0.55425060
719	2.5	1	1.5	2	0.6	G5	0.37549600	-0.16332278	0.75053322	-1.13411462	1.04303885	-0.45642600	0.02521256
720	2.5	1	1.5	2	0.6	G6	-0.08866137	0.03134145	-0.52183628	1.87341845	-2.55950499	1.73492360	-0.46810448
721	2.5	1	1.5	2	0.8	G0	0.90929627	-1.09197210	3.05009420	-6.85205310	10.49534400	-8.21087050	2.44127580
722	2.5	1	1.5	2	0.8	G1	0.15779737	0.39687258	0.92377728	-3.11677120	4.99886410	-3.90826330	1.10835490
723	2.5	1	1.5	2	0.8	G5	0.40270487	-0.19432773	1.06024325	-1.83396482	2.59010911	-1.97603440	0.51214755
724	2.5	1	1.5	2	0.8	G6	-0.11934244	-0.02338026	-0.34172607	0.96085942	-0.47017461	-0.12743814	0.12262033
725	3	0.015625	2	0.03125	0.2	G0	too long						
726	3	0.015625	2	0.03125	0.2	G1	too long						
727	3	0.015625	2	0.03125	0.2	G5	too long						
728	3	0.015625	2	0.03125	0.2	G6	too long						
729	3	0.015625	2	0.03125	0.4	G0	too long						
730	3	0.015625	2	0.03125	0.4	G1	too long						
731	3	0.015625	2	0.03125	0.4	G5	too long						
732	3	0.015625	2	0.03125	0.4	G6	too long						
733	3	0.015625	2	0.03125	0.6	G0	too long						
734	3	0.015625	2	0.03125	0.6	G1	too long						
735	3	0.015625	2	0.03125	0.6	G5	too long						
736	3	0.015625	2	0.03125	0.6	G6	too long						
737	3	0.015625	2	0.03125	0.8	G0	too long						
738	3	0.015625	2	0.03125	0.8	G1	too long						
739	3	0.015625	2	0.03125	0.8	G5	too long						
740	3	0.015625	2	0.03125	0.8	G6	too long						
741	3	0.03125	2	0.0625	0.2	G0	too long						
742	3	0.03125	2	0.0625	0.2	G1	too long						
743	3	0.03125	2	0.0625	0.2	G5	too long						
744	3	0.03125	2	0.0625	0.2	G6	too long						
745	3	0.03125	2	0.0625	0.4	G0	too long						

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
746	3	0.03125	2	0.0625	0.4	G1	too long						
747	3	0.03125	2	0.0625	0.4	G5	too long						
748	3	0.03125	2	0.0625	0.4	G6	too long						
749	3	0.03125	2	0.0625	0.6	G0	too long						
750	3	0.03125	2	0.0625	0.6	G1	too long						
751	3	0.03125	2	0.0625	0.6	G5	too long						
752	3	0.03125	2	0.0625	0.6	G6	too long						
753	3	0.03125	2	0.0625	0.8	G0	too long						
754	3	0.03125	2	0.0625	0.8	G1	too long						
755	3	0.03125	2	0.0625	0.8	G5	too long						
756	3	0.03125	2	0.0625	0.8	G6	too long						
757	3	0.0625	2	0.125	0.2	G0	too long						
758	3	0.0625	2	0.125	0.2	G1	too long						
759	3	0.0625	2	0.125	0.2	G5	too long						
760	3	0.0625	2	0.125	0.2	G6	too long						
761	3	0.0625	2	0.125	0.4	G0	too long						
762	3	0.0625	2	0.125	0.4	G1	too long						
763	3	0.0625	2	0.125	0.4	G5	too long						
764	3	0.0625	2	0.125	0.4	G6	too long						
765	3	0.0625	2	0.125	0.6	G0	too long						
766	3	0.0625	2	0.125	0.6	G1	too long						
767	3	0.0625	2	0.125	0.6	G5	too long						
768	3	0.0625	2	0.125	0.6	G6	too long						
769	3	0.0625	2	0.125	0.8	G0	too long						
770	3	0.0625	2	0.125	0.8	G1	too long						
771	3	0.0625	2	0.125	0.8	G5	too long						
772	3	0.0625	2	0.125	0.8	G6	too long						
773	3	0.125	2	0.25	0.2	G0	0.52303107	-0.00343024	4.87819010	-13.58102100	18.06545000	-12.21787800	3.30842450

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
774	3	0.125	2	0.25	0.2	G1	0.05940204	0.12975568	2.23892030	-3.29216440	2.77994850	-1.82619600	0.54773651
775	3	0.125	2	0.25	0.2	G5	0.03169308	-0.04903194	0.45566663	0.20296109	1.16078401	-2.32888055	0.92025989
776	3	0.125	2	0.25	0.2	G6	-0.15882015	-0.20781618	-0.60546643	0.92767274	0.56886739	-0.42032099	-0.10436173
777	3	0.125	2	0.25	0.4	G0	too long						
778	3	0.125	2	0.25	0.4	G1	too long						
779	3	0.125	2	0.25	0.4	G5	too long						
780	3	0.125	2	0.25	0.4	G6	too long						
781	3	0.125	2	0.25	0.6	G0	too long						
782	3	0.125	2	0.25	0.6	G1	too long						
783	3	0.125	2	0.25	0.6	G5	too long						
784	3	0.125	2	0.25	0.6	G6	too long						
785	3	0.125	2	0.25	0.8	G0	too long						
786	3	0.125	2	0.25	0.8	G1	too long						
787	3	0.125	2	0.25	0.8	G5	too long						
788	3	0.125	2	0.25	0.8	G6	too long						
789	3	0.25	2	0.5	0.2	G0	0.82996596	-1.28526820	6.70219040	-13.03829100	13.94719500	-8.15751590	2.00149380
790	3	0.25	2	0.5	0.2	G1	0.11808639	0.23784717	1.16745150	-0.32566665	-1.19596960	0.83279041	-0.16270838
791	3	0.25	2	0.5	0.2	G5	0.22848250	-0.26221597	1.46359301	-1.60139465	0.78236222	-0.17446783	-0.02262583
792	3	0.25	2	0.5	0.2	G6	-0.16182914	0.13820688	-0.69444019	0.77105540	0.71330833	-1.11902058	0.35247490
793	3	0.25	2	0.5	0.4	G0	0.82456077	-1.62712250	8.25163250	-16.04966800	17.10200200	-9.89510970	2.39256390
794	3	0.25	2	0.5	0.4	G1	0.12024632	0.16396541	1.26414060	-0.04407931	-1.88882500	1.38423580	-0.32128386
795	3	0.25	2	0.5	0.4	G5	0.08132229	-0.15026158	0.84751791	-0.83660579	3.31717038	-4.31093645	1.54053211
796	3	0.25	2	0.5	0.4	G6	-0.25731441	0.30456251	-1.83058548	1.69076896	1.17957139	-1.16013265	0.07297307
797	3	0.25	2	0.5	0.6	G0	0.86096135	-2.10231250	10.88624700	-22.70784500	26.42522800	-16.35601500	4.09060040
798	3	0.25	2	0.5	0.6	G1	0.13907774	0.01473397	1.88833390	-1.37325210	-0.01332183	0.06565121	0.00751361
799	3	0.25	2	0.5	0.6	G5	-0.08225277	-0.06752549	0.35834885	-3.73531008	15.14156720	-16.06050110	5.03608131
800	3	0.25	2	0.5	0.6	G6	-0.23510140	0.36045462	-2.19789910	1.28375483	-1.51760626	5.67287636	-3.36742640
801	3	0.25	2	0.5	0.8	G0	too long						

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
802	3	0.25	2	0.5	0.8	G1	too long						
803	3	0.25	2	0.5	0.8	G5	too long						
804	3	0.25	2	0.5	0.8	G6	too long						
805	3	0.5	2	1	0.2	G0	1.16845310	-1.25850720	3.52794260	-5.72810680	6.76225720	-4.86811620	1.45006080
806	3	0.5	2	1	0.2	G1	0.18427408	0.49714981	0.88636134	-1.67582460	2.33264770	-2.25113830	0.78184213
807	3	0.5	2	1	0.2	G5	0.39209375	-0.30821952	1.01440203	-1.16445732	1.01833653	-0.72522515	0.22034070
808	3	0.5	2	1	0.2	G6	-0.10450943	0.10349040	-0.53794920	1.84293628	-3.00233197	2.54539728	-0.84680688
809	3	0.5	2	1	0.4	G0	1.17563740	-1.60911760	4.33125450	-5.44291990	4.85490220	-3.21059190	0.98944531
810	3	0.5	2	1	0.4	G1	0.19392965	0.41487997	0.75065569	-0.69642868	1.19231750	-1.86930630	0.79468419
811	3	0.5	2	1	0.4	G5	0.36557415	-0.34659374	1.20606565	-0.74257988	0.63551372	-0.96449184	0.40721846
812	3	0.5	2	1	0.4	G6	-0.20440835	0.09074152	-0.32116273	0.08293387	0.90987295	-0.54106426	-0.01716332
813	3	0.5	2	1	0.6	G0	1.21152680	-1.95315200	5.20401100	-5.05746560	2.23456380	-0.59848966	0.13128570
814	3	0.5	2	1	0.6	G1	0.21609208	0.31530286	0.67160037	0.54336836	-0.89810235	-0.45055306	0.42898526
815	3	0.5	2	1	0.6	G5	0.31824330	-0.44693521	1.67781377	-1.65436220	3.50364161	-4.25789070	1.55677474
816	3	0.5	2	1	0.6	G6	-0.29384607	0.12656048	-0.64830411	-0.35781986	2.56845045	-1.34782028	-0.04765812
817	3	0.5	2	1	0.8	G0	1.32368420	-2.57246770	7.42962080	-8.10884280	4.87370780	-1.40655800	-0.07703320
818	3	0.5	2	1	0.8	G1	0.27284634	0.07675564	1.24313310	0.32894653	-1.10722100	0.14309946	0.02460122
819	3	0.5	2	1	0.8	G5	0.27788791	-0.68061101	2.44394088	-3.63147831	8.82765388	-9.08603382	2.79292440
820	3	0.5	2	1	0.8	G6	-0.36477563	0.19052516	-1.16348803	-0.52890110	2.65945315	0.40730241	-1.20076156
821	3	1	2	2	0.2	G0	0.82200894	-0.65730546	1.32116430	-2.38351980	2.24761220	-0.86541941	0.08372799
822	3	1	2	2	0.2	G1	0.11380396	0.53131199	0.36355429	-0.66605912	-0.78275223	1.49255120	-0.59982831
823	3	1	2	2	0.2	G5	0.28390253	-0.13213556	0.37559778	-0.49170521	0.00579923	0.41592839	-0.20843308
824	3	1	2	2	0.2	G6	-0.03111196	0.02498739	-0.12983467	0.41402084	-0.54629731	0.39755568	-0.12802979
825	3	1	2	2	0.4	G0	0.84317279	-0.86683038	2.27546650	-5.19594150	7.41234300	-5.32324900	1.48021570
826	3	1	2	2	0.4	G1	0.12697159	0.46659497	0.68446833	-2.18360810	2.61444400	-1.55812920	0.34007843
827	3	1	2	2	0.4	G5	0.30085221	-0.13583645	0.68535912	-1.33326244	1.52567840	-0.88211632	0.17717969
828	3	1	2	2	0.4	G6	-0.06501139	0.03054744	-0.41086477	1.58551204	-2.43660307	1.85220623	-0.55450070
829	3	1	2	2	0.6	G0	0.87049779	-1.03594710	2.80004950	-6.30812130	9.69171600	-7.65471660	2.31612590

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
830	3	1	2	2	0.6	G1	0.14302528	0.41016519	0.82387099	-2.87396950	4.61880490	-3.67732790	1.07964180
831	3	1	2	2	0.6	G5	0.31712103	-0.14073974	0.78385514	-1.34100664	1.90595794	-1.51288402	0.42035779
832	3	1	2	2	0.6	G6	-0.09889083	-0.01777500	-0.28957745	0.79612792	-0.34321445	-0.17501880	0.12962598
833	3	1	2	2	0.8	G0	0.92070223	-1.21870890	3.32665650	-6.92003820	10.75202500	-8.76129230	2.69349820
834	3	1	2	2	0.8	G1	0.16985281	0.34469395	0.95084995	-3.18527660	5.74287830	-4.93421540	1.50264720
835	3	1	2	2	0.8	G5	0.34328100	-0.21026152	1.17661238	-2.18685031	3.93676782	-3.59423661	1.10571456
836	3	1	2	2	0.8	G6	-0.13382736	-0.09338440	-0.32492173	1.45207667	-2.17085004	2.07004952	-0.79822153
837	3.5	0.015625	2.5	0.03125	0.2	G0	too long						
838	3.5	0.015625	2.5	0.03125	0.2	G1	too long						
839	3.5	0.015625	2.5	0.03125	0.2	G5	too long						
840	3.5	0.015625	2.5	0.03125	0.2	G6	too long						
841	3.5	0.015625	2.5	0.03125	0.4	G0	too long						
842	3.5	0.015625	2.5	0.03125	0.4	G1	too long						
843	3.5	0.015625	2.5	0.03125	0.4	G5	too long						
844	3.5	0.015625	2.5	0.03125	0.4	G6	too long						
845	3.5	0.015625	2.5	0.03125	0.6	G0	too long						
846	3.5	0.015625	2.5	0.03125	0.6	G1	too long						
847	3.5	0.015625	2.5	0.03125	0.6	G5	too long						
848	3.5	0.015625	2.5	0.03125	0.6	G6	too long						
849	3.5	0.015625	2.5	0.03125	0.8	G0	too long						
850	3.5	0.015625	2.5	0.03125	0.8	G1	too long						
851	3.5	0.015625	2.5	0.03125	0.8	G5	too long						
852	3.5	0.015625	2.5	0.03125	0.8	G6	too long						
853	3.5	0.03125	2.5	0.0625	0.2	G0	too long						
854	3.5	0.03125	2.5	0.0625	0.2	G1	too long						
855	3.5	0.03125	2.5	0.0625	0.2	G5	too long						
856	3.5	0.03125	2.5	0.0625	0.2	G6	too long						
857	3.5	0.03125	2.5	0.0625	0.4	G0	too long						

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
858	3.5	0.03125	2.5	0.0625	0.4	G1	too long						
859	3.5	0.03125	2.5	0.0625	0.4	G5	too long						
860	3.5	0.03125	2.5	0.0625	0.4	G6	too long						
861	3.5	0.03125	2.5	0.0625	0.6	G0	too long						
862	3.5	0.03125	2.5	0.0625	0.6	G1	too long						
863	3.5	0.03125	2.5	0.0625	0.6	G5	too long						
864	3.5	0.03125	2.5	0.0625	0.6	G6	too long						
865	3.5	0.03125	2.5	0.0625	0.8	G0	too long						
866	3.5	0.03125	2.5	0.0625	0.8	G1	too long						
867	3.5	0.03125	2.5	0.0625	0.8	G5	too long						
868	3.5	0.03125	2.5	0.0625	0.8	G6	too long						
869	3.5	0.0625	2.5	0.125	0.2	G0	too long						
870	3.5	0.0625	2.5	0.125	0.2	G1	too long						
871	3.5	0.0625	2.5	0.125	0.2	G5	too long						
872	3.5	0.0625	2.5	0.125	0.2	G6	too long						
873	3.5	0.0625	2.5	0.125	0.4	G0	too long						
874	3.5	0.0625	2.5	0.125	0.4	G1	too long						
875	3.5	0.0625	2.5	0.125	0.4	G5	too long						
876	3.5	0.0625	2.5	0.125	0.4	G6	too long						
877	3.5	0.0625	2.5	0.125	0.6	G0	too long						
878	3.5	0.0625	2.5	0.125	0.6	G1	too long						
879	3.5	0.0625	2.5	0.125	0.6	G5	too long						
880	3.5	0.0625	2.5	0.125	0.6	G6	too long						
881	3.5	0.0625	2.5	0.125	0.8	G0	too long						
882	3.5	0.0625	2.5	0.125	0.8	G1	too long						
883	3.5	0.0625	2.5	0.125	0.8	G5	too long						
884	3.5	0.0625	2.5	0.125	0.8	G6	too long						
885	3.5	0.125	2.5	0.25	0.2	G0	0.51574819	-0.06856692	5.22044060	-14.60285800	19.53607200	-13.23843500	3.58663210

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
886	3.5	0.125	2.5	0.25	0.2	G1	0.05821087	0.11092907	2.30478610	-3.45645650	2.97692650	-1.93806240	0.57299139
887	3.5	0.125	2.5	0.25	0.2	G5	-0.02485150	-0.10796206	0.30537283	-0.17046428	3.47000694	-4.89211178	1.76367903
888	3.5	0.125	2.5	0.25	0.2	G6	-0.12875526	-0.17171887	-0.58813572	0.29366112	0.91326642	0.27808052	-0.59678149
889	3.5	0.125	2.5	0.25	0.4	G0	too long						
890	3.5	0.125	2.5	0.25	0.4	G1	too long						
891	3.5	0.125	2.5	0.25	0.4	G5	too long						
892	3.5	0.125	2.5	0.25	0.4	G6	too long						
893	3.5	0.125	2.5	0.25	0.6	G0	too long						
894	3.5	0.125	2.5	0.25	0.6	G1	too long						
895	3.5	0.125	2.5	0.25	0.6	G5	too long						
896	3.5	0.125	2.5	0.25	0.6	G6	too long						
897	3.5	0.125	2.5	0.25	0.8	G0	too long						
898	3.5	0.125	2.5	0.25	0.8	G1	too long						
899	3.5	0.125	2.5	0.25	0.8	G5	too long						
900	3.5	0.125	2.5	0.25	0.8	G6	too long						
901	3.5	0.25	2.5	0.5	0.2	G0	0.81724453	-1.34811820	6.95720950	-13.44890500	14.22762100	-8.20452130	1.98422030
902	3.5	0.25	2.5	0.5	0.2	G1	0.11486239	0.22677246	1.14385100	-0.13924274	-1.53235190	1.09134820	-0.23755555
903	3.5	0.25	2.5	0.5	0.2	G5	0.16764449	-0.21342011	1.26084948	-1.56085420	1.57543802	-1.25491738	0.39062804
904	3.5	0.25	2.5	0.5	0.2	G6	-0.16938029	0.26088351	-1.52277994	2.76464748	-1.64853859	0.30208486	0.01319033
905	3.5	0.25	2.5	0.5	0.4	G0	0.81136422	-1.78627840	9.19745370	-18.48218200	20.26693800	-11.94531900	2.91900710
906	3.5	0.25	2.5	0.5	0.4	G1	0.11754042	0.12610191	1.38318700	-0.19730629	-1.81386390	1.39722880	-0.33904500
907	3.5	0.25	2.5	0.5	0.4	G5	-0.00917128	-0.06179952	0.33064944	-1.06869340	6.24876833	-7.57720852	2.57975149
908	3.5	0.25	2.5	0.5	0.4	G6	-0.22057031	0.30087799	-1.87474895	1.50507021	0.38050109	0.81728989	-0.90884858
909	3.5	0.25	2.5	0.5	0.6	G0	0.94553588	-2.75549550	13.36192300	-28.31216500	33.36841600	-20.64540200	5.12128300
910	3.5	0.25	2.5	0.5	0.6	G1	0.16551690	-0.16384153	2.45517480	-2.52974640	1.32396900	-0.67236946	0.14912046
911	3.5	0.25	2.5	0.5	0.6	G5	-0.16082405	-0.02482829	0.64654970	-9.20237637	26.96508220	-24.36499600	6.68082142
912	3.5	0.25	2.5	0.5	0.6	G6	-0.09325241	0.10017152	-0.90548515	0.43583679	-8.78297901	17.69764900	-8.45331097
913	3.5	0.25	2.5	0.5	0.8	G0	too long						

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
914	3.5	0.25	2.5	0.5	0.8	G1	too long						
915	3.5	0.25	2.5	0.5	0.8	G5	too long						
916	3.5	0.25	2.5	0.5	0.8	G6	too long						
917	3.5	0.5	2.5	1	0.2	G0	1.15909000	-1.29575560	3.43737560	-4.91453030	5.37803620	-3.92559950	1.21786540
918	3.5	0.5	2.5	1	0.2	G1	0.18303758	0.49208424	0.77140408	-1.27617870	1.93878970	-2.14919820	0.79952105
919	3.5	0.5	2.5	1	0.2	G5	0.32899809	-0.26923266	0.97621739	-1.28871691	1.56683505	-1.38491452	0.47500643
920	3.5	0.5	2.5	1	0.2	G6	-0.11086557	0.11510433	-0.63329071	1.75134420	-2.13657665	1.39005756	-0.37518948
921	3.5	0.5	2.5	1	0.4	G0	1.15940140	-1.71093460	4.52286700	-4.81330830	2.98785660	-1.50988050	0.45419161
922	3.5	0.5	2.5	1	0.4	G1	0.19160694	0.39269158	0.61586774	0.06166423	0.00794522	-1.08291140	0.59862641
923	3.5	0.5	2.5	1	0.4	G5	0.28371030	-0.31410402	1.18642497	-0.97545278	1.65092230	-2.13053036	0.82115150
924	3.5	0.5	2.5	1	0.4	G6	-0.21568959	0.15278655	-0.79281622	0.85569370	0.47441500	-0.47015744	-0.00417076
925	3.5	0.5	2.5	1	0.6	G0	1.19663460	-2.15730610	5.97113870	-5.71011810	1.80209530	0.34273193	-0.26203294
926	3.5	0.5	2.5	1	0.6	G1	0.21554150	0.25824743	0.64726442	1.25012390	-2.25611530	0.59409875	0.12749264
927	3.5	0.5	2.5	1	0.6	G5	0.21008495	-0.41819474	1.49704075	-1.74025786	5.00325394	-5.95378780	2.06497431
928	3.5	0.5	2.5	1	0.6	G6	-0.29312331	0.13208666	-0.68920654	-1.23375940	4.08191252	-1.84423542	-0.15431595
929	3.5	0.5	2.5	1	0.8	G0	1.32158590	-2.97404950	9.20845590	-11.54655600	8.52355650	-3.14676480	0.12758691
930	3.5	0.5	2.5	1	0.8	G1	0.27863564	-0.06450045	1.57881160	0.15695712	-1.25356790	0.48752515	-0.16973371
931	3.5	0.5	2.5	1	0.8	G5	0.14170979	-0.70375907	2.52541590	-5.99050808	15.43965630	-14.72728250	4.23100805
932	3.5	0.5	2.5	1	0.8	G6	-0.33914617	0.25968698	-1.55122733	-0.24915361	0.35982657	4.76004601	-3.24095774
933	3.5	1	2.5	2	0.2	G0	0.82331405	-0.68963354	1.46392090	-2.87088620	3.29482750	-1.83671270	0.39749125
934	3.5	1	2.5	2	0.2	G1	0.11586610	0.52073445	0.42736837	-1.04307430	0.10007298	0.70039401	-0.35891844
935	3.5	1	2.5	2	0.2	G5	0.24527609	-0.10954817	0.39153555	-0.66851091	0.48209029	-0.06192571	-0.04790647
936	3.5	1	2.5	2	0.2	G6	-0.03358381	0.02065913	-0.13428721	0.51631922	-0.83973932	0.72398388	-0.25236937
937	3.5	1	2.5	2	0.4	G0	0.84409362	-0.91908731	2.41853620	-5.51679880	8.27988210	-6.31265510	1.84953810
938	3.5	1	2.5	2	0.4	G1	0.13028823	0.44895972	0.71790545	-2.48187620	3.58208950	-2.59416910	0.70016983
939	3.5	1	2.5	2	0.4	G5	0.26010200	-0.11233010	0.67155290	-1.41496527	2.00586414	-1.49764097	0.41272646
940	3.5	1	2.5	2	0.4	G6	-0.06980798	0.01723279	-0.39807683	1.34233141	-1.62160301	0.94251341	-0.21116844
941	3.5	1	2.5	2	0.6	G0	0.87319857	-1.12660490	3.03827160	-6.57267290	10.28497000	-8.43454060	2.64062240

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
942	3.5	1	2.5	2	0.6	G1	0.14847408	0.37649452	0.85147392	-3.01993760	5.37318960	-4.63985380	1.44970080
943	3.5	1	2.5	2	0.6	G5	0.27333835	-0.15249778	0.94212729	-1.97082710	3.52027273	-3.21688843	1.03155541
944	3.5	1	2.5	2	0.6	G6	-0.10629123	-0.07790466	-0.12032030	0.58223355	-0.61494941	0.63036138	-0.29229564
945	3.5	1	2.5	2	0.8	G0	0.93295220	-1.36099260	3.59415410	-6.65764680	10.08179000	-8.37450160	2.62205140
946	3.5	1	2.5	2	0.8	G1	0.18144524	0.28510332	0.94976639	-2.92499540	5.68390090	-5.21065420	1.65344010
947	3.5	1	2.5	2	0.8	G5	0.29656106	-0.23684809	1.04509151	-1.38929999	3.01786256	-3.15451193	0.99956942
948	3.5	1	2.5	2	0.8	G6	-0.14509910	-0.11930071	-0.40394473	1.42039430	-1.90763092	1.99071348	-0.83411539
949	4	0.015625	3	0.03125	0.2	G0	too long						
950	4	0.015625	3	0.03125	0.2	G1	too long						
951	4	0.015625	3	0.03125	0.2	G5	too long						
952	4	0.015625	3	0.03125	0.2	G6	too long						
953	4	0.015625	3	0.03125	0.4	G0	too long						
954	4	0.015625	3	0.03125	0.4	G1	too long						
955	4	0.015625	3	0.03125	0.4	G5	too long						
956	4	0.015625	3	0.03125	0.4	G6	too long						
957	4	0.015625	3	0.03125	0.6	G0	too long						
958	4	0.015625	3	0.03125	0.6	G1	too long						
959	4	0.015625	3	0.03125	0.6	G5	too long						
960	4	0.015625	3	0.03125	0.6	G6	too long						
961	4	0.015625	3	0.03125	0.8	G0	too long						
962	4	0.015625	3	0.03125	0.8	G1	too long						
963	4	0.015625	3	0.03125	0.8	G5	too long						
964	4	0.015625	3	0.03125	0.8	G6	too long						
965	4	0.03125	3	0.0625	0.2	G0	too long						
966	4	0.03125	3	0.0625	0.2	G1	too long						
967	4	0.03125	3	0.0625	0.2	G5	too long						
968	4	0.03125	3	0.0625	0.2	G6	too long						
969	4	0.03125	3	0.0625	0.4	G0	too long						

STP-PT-071: Stress Intensity Factor Solutions for Internal Cracks in Thick-Walled Cylinder Vessels

Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
970	4	0.03125	3	0.0625	0.4	G1	too long						
971	4	0.03125	3	0.0625	0.4	G5	too long						
972	4	0.03125	3	0.0625	0.4	G6	too long						
973	4	0.03125	3	0.0625	0.6	G0	too long						
974	4	0.03125	3	0.0625	0.6	G1	too long						
975	4	0.03125	3	0.0625	0.6	G5	too long						
976	4	0.03125	3	0.0625	0.6	G6	too long						
977	4	0.03125	3	0.0625	0.8	G0	too long						
978	4	0.03125	3	0.0625	0.8	G1	too long						
979	4	0.03125	3	0.0625	0.8	G5	too long						
980	4	0.03125	3	0.0625	0.8	G6	too long						
981	4	0.0625	3	0.125	0.2	G0	too long						
982	4	0.0625	3	0.125	0.2	G1	too long						
983	4	0.0625	3	0.125	0.2	G5	too long						
984	4	0.0625	3	0.125	0.2	G6	too long						
985	4	0.0625	3	0.125	0.4	G0	too long						
986	4	0.0625	3	0.125	0.4	G1	too long						
987	4	0.0625	3	0.125	0.4	G5	too long						
988	4	0.0625	3	0.125	0.4	G6	too long						
989	4	0.0625	3	0.125	0.6	G0	too long						
990	4	0.0625	3	0.125	0.6	G1	too long						
991	4	0.0625	3	0.125	0.6	G5	too long						
992	4	0.0625	3	0.125	0.6	G6	too long						
993	4	0.0625	3	0.125	0.8	G0	too long						
994	4	0.0625	3	0.125	0.8	G1	too long						
995	4	0.0625	3	0.125	0.8	G5	too long						
996	4	0.0625	3	0.125	0.8	G6	too long						
997	4	0.125	3	0.25	0.2	G0	0.50926326	-0.11165756	5.43866200	-15.26322200	20.47737500	-13.87847400	3.75732440

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
998	4	0.125	3	0.25	0.2	G1	0.05744857	0.09615872	2.35327250	-3.57563600	3.11327280	-2.00943090	0.58747057
999	4	0.125	3	0.25	0.2	G5	-0.05984806	-0.17225832	0.33579886	-1.29690552	6.68870544	-7.74394703	2.55494642
1000	4	0.125	3	0.25	0.2	G6	-0.08951440	-0.13550094	-0.43829215	-0.44993949	0.66969204	1.91387975	-1.47092223
1001	4	0.125	3	0.25	0.4	G0	too long						
1002	4	0.125	3	0.25	0.4	G1	too long						
1003	4	0.125	3	0.25	0.4	G5	too long						
1004	4	0.125	3	0.25	0.4	G6	too long						
1005	4	0.125	3	0.25	0.6	G0	too long						
1006	4	0.125	3	0.25	0.6	G1	too long						
1007	4	0.125	3	0.25	0.6	G5	too long						
1008	4	0.125	3	0.25	0.6	G6	too long						
1009	4	0.125	3	0.25	0.8	G0	too long						
1010	4	0.125	3	0.25	0.8	G1	too long						
1011	4	0.125	3	0.25	0.8	G5	too long						
1012	4	0.125	3	0.25	0.8	G6	too long						
1013	4	0.25	3	0.5	0.2	G0	0.80800041	-1.41737550	7.27760290	-14.06916800	14.80265400	-8.44795710	2.01838010
1014	4	0.25	3	0.5	0.2	G1	0.11261324	0.21345660	1.14066850	-0.00195621	-1.82095390	1.33020140	-0.30971287
1015	4	0.25	3	0.5	0.2	G5	0.11867335	-0.15871628	0.92996365	-0.92793816	1.20872140	-1.28297734	0.44277337
1016	4	0.25	3	0.5	0.2	G6	-0.16380714	0.15930067	-0.91799682	0.91955888	0.88207865	-1.20933938	0.33009258
1017	4	0.25	3	0.5	0.4	G0	0.80503833	-1.94022740	10.12494000	-20.90489400	23.41531700	-13.96010200	3.42706960
1018	4	0.25	3	0.5	0.4	G1	0.11723505	0.08587962	1.52489940	-0.42090982	-1.65954190	1.37654690	-0.35371648
1019	4	0.25	3	0.5	0.4	G5	-0.07122735	-0.01946168	0.15292144	-2.64731598	11.19489570	-12.04485510	3.84290838
1020	4	0.25	3	0.5	0.4	G6	-0.16885521	0.26857621	-1.67117333	1.14098334	-1.31717968	4.20240831	-2.45546198
1021	4	0.25	3	0.5	0.6	G0	too long						
1022	4	0.25	3	0.5	0.6	G1	too long						
1023	4	0.25	3	0.5	0.6	G5	too long						
1024	4	0.25	3	0.5	0.6	G6	too long						
1025	4	0.25	3	0.5	0.8	G0	too long						

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
1026	4	0.25	3	0.5	0.8	G1	too long						
1027	4	0.25	3	0.5	0.8	G5	too long						
1028	4	0.25	3	0.5	0.8	G6	too long						
1029	4	0.5	3	1	0.2	G0	1.15094820	-1.37481200	3.65158410	-4.91277500	4.96310230	-3.50173050	1.08163990
1030	4	0.5	3	1	0.2	G1	0.18213511	0.47196689	0.75435080	-1.09848510	1.74753200	-2.10613310	0.81144703
1031	4	0.5	3	1	0.2	G5	0.27994177	-0.22209615	0.72016501	-0.38883206	0.04473536	-0.14299381	0.07997916
1032	4	0.5	3	1	0.2	G6	-0.11437794	0.09054801	-0.32698941	0.19774807	0.99904370	-1.34313166	0.49754149
1033	4	0.5	3	1	0.4	G0	1.14558630	-1.81691670	4.79629150	-4.47614940	1.50239850	-0.01946310	-0.04080768
1034	4	0.5	3	1	0.4	G1	0.18976541	0.36789907	0.50970493	0.76785712	-1.19120570	-0.22037880	0.36559251
1035	4	0.5	3	1	0.4	G5	0.21711433	-0.28082842	1.01550424	-0.63546574	1.61123776	-2.32745123	0.89157373
1036	4	0.5	3	1	0.4	G6	-0.21532670	0.07931064	-0.41218978	-0.42039287	2.07977486	-1.09329104	-0.01822513
1037	4	0.5	3	1	0.6	G0	1.18778770	-2.36089150	6.78103640	-6.63602630	1.79469880	1.03334410	-0.60807392
1038	4	0.5	3	1	0.6	G1	0.21634059	0.19815773	0.66441677	1.82664900	-3.49828600	1.63064660	-0.19303305
1039	4	0.5	3	1	0.6	G5	0.12209099	-0.41989148	1.51303279	-2.94031906	8.65663052	-9.32989407	3.03367352
1040	4	0.5	3	1	0.6	G6	-0.27870131	0.15970843	-0.82369810	-1.63359904	4.27087021	-0.93586236	-0.75941324
1041	4	0.5	3	1	0.8	G0	1.33849310	-3.43041320	11.32206300	-16.27761400	14.12957700	-6.17057570	0.64146062
1042	4	0.5	3	1	0.8	G1	0.28982263	-0.22957484	2.09203560	-0.66789430	-0.46304631	0.25770711	-0.23937613
1043	4	0.5	3	1	0.8	G5	0.03698258	-0.73419744	2.84765816	-10.05532930	24.81736950	-21.87211610	5.84726238
1044	4	0.5	3	1	0.8	G6	-0.28724262	0.34502798	-1.93709004	1.04145241	-5.63869381	13.22116570	-6.74557781
1045	4	1	3	2	0.2	G0	0.82464143	-0.73150114	1.68883610	-3.62219300	4.73675210	-3.09316740	0.79152424
1046	4	1	3	2	0.2	G1	0.11796054	0.50477575	0.52918143	-1.52994440	1.14093640	-0.20850053	-0.08317403
1047	4	1	3	2	0.2	G5	0.21588273	-0.08459159	0.31495845	-0.44311357	0.17181550	0.16398946	-0.12170297
1048	4	1	3	2	0.2	G6	-0.03567111	0.02347752	-0.20662497	0.84098983	-1.44993973	1.24724722	-0.41857624
1049	4	1	3	2	0.4	G0	0.84540291	-0.98486630	2.61727270	-5.84588610	8.91661410	-6.98456130	2.09493930
1050	4	1	3	2	0.4	G1	0.13356932	0.42569080	0.75991509	-2.70281970	4.30554160	-3.38976100	0.98176151
1051	4	1	3	2	0.4	G5	0.22847483	-0.09075126	0.54265785	-0.91804600	1.28648555	-1.00393462	0.27043551
1052	4	1	3	2	0.4	G6	-0.07339308	-0.01286347	-0.20819917	0.50970012	-0.02312365	-0.38229832	0.19133486
1053	4	1	3	2	0.6	G0	0.87585846	-1.20984400	3.16452160	-6.28852290	9.73865390	-8.18729290	2.62963470

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Run ID	Y = OD/ID	a/l = a/(2*c)	t/Ri	a/c	a/t	Gi	A0	A1	A2	A3	A4	A5	A6
1054	4	1	3	2	0.6	G1	0.15349099	0.34535108	0.81844869	-2.82912930	5.41873680	-4.97540230	1.62081330
1055	4	1	3	2	0.6	G5	0.23768526	-0.15012734	0.79681885	-1.32593989	2.71409297	-2.78160810	0.93088043
1056	4	1	3	2	0.6	G6	-0.11278015	-0.07114110	-0.45902938	1.79955506	-2.72095156	2.47439885	-0.90905106
1057	4	1	3	2	0.8	G0	0.94610155	-1.52322710	3.92992110	-6.41218860	9.12624580	-7.57161060	2.38230340
1058	4	1	3	2	0.8	G1	0.19261391	0.21632094	0.96615361	-2.55110920	5.21591810	-5.04777370	1.64929530
1059	4	1	3	2	0.8	G5	0.25821620	-0.31445757	1.20667291	-1.66613626	3.95598555	-4.19583607	1.33950818
1060	4	1	3	2	0.8	G6	-0.15098801	-0.19299153	-0.15229219	0.72981042	-1.48542988	2.48404646	-1.23150122

APPENDIX D - CIRCUMFERENTIAL INTERNAL 360° CRACK RESULTS

The circumferential internal 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 (4th order) crack face pressure.

Table 4. Non-dimensional Geometry Polynomial Coefficient Values for Circumferential Internal 360° Cracks

Run ID	Y=OD/ID	t/Ri	a/t	Gi	A0
1101	2	1	0.2	G0	1.05316946
1102	2	1	0.2	G1	0.65865379
1103	2	1	0.2	G2	0.51266931
1104	2	1	0.2	G3	0.43289635
1105	2	1	0.2	G4	0.38121608
1106	2	1	0.4	G0	1.08081383
1107	2	1	0.4	G1	0.67366536
1108	2	1	0.4	G2	0.52249923
1109	2	1	0.4	G3	0.43996501
1110	2	1	0.4	G4	0.38660224
1111	2	1	0.6	G0	1.20159533
1112	2	1	0.6	G1	0.73135023
1113	2	1	0.6	G2	0.55862113
1114	2	1	0.6	G3	0.46543565
1115	2	1	0.6	G4	0.40584128
1116	2	1	0.8	G0	1.55042444
1117	2	1	0.8	G1	0.90589355
1118	2	1	0.8	G2	0.67100324
1119	2	1	0.8	G3	0.54621451
1120	2	1	0.8	G4	0.46773345
1121	2.5	1.5	0.2	G0	0.99992796
1122	2.5	1.5	0.2	G1	0.63833200
1123	2.5	1.5	0.2	G2	0.50132125
1124	2.5	1.5	0.2	G3	0.42540785
1125	2.5	1.5	0.2	G4	0.37577938
1126	2.5	1.5	0.4	G0	0.99673749
1127	2.5	1.5	0.4	G1	0.64185819
1128	2.5	1.5	0.4	G2	0.50488185
1129	2.5	1.5	0.4	G3	0.42844045
1130	2.5	1.5	0.4	G4	0.37831805
1131	2.5	1.5	0.6	G0	1.09264577
1132	2.5	1.5	0.6	G1	0.69108515
1133	2.5	1.5	0.6	G2	0.53667945
1134	2.5	1.5	0.6	G3	0.45125860
1135	2.5	1.5	0.6	G4	0.39575213

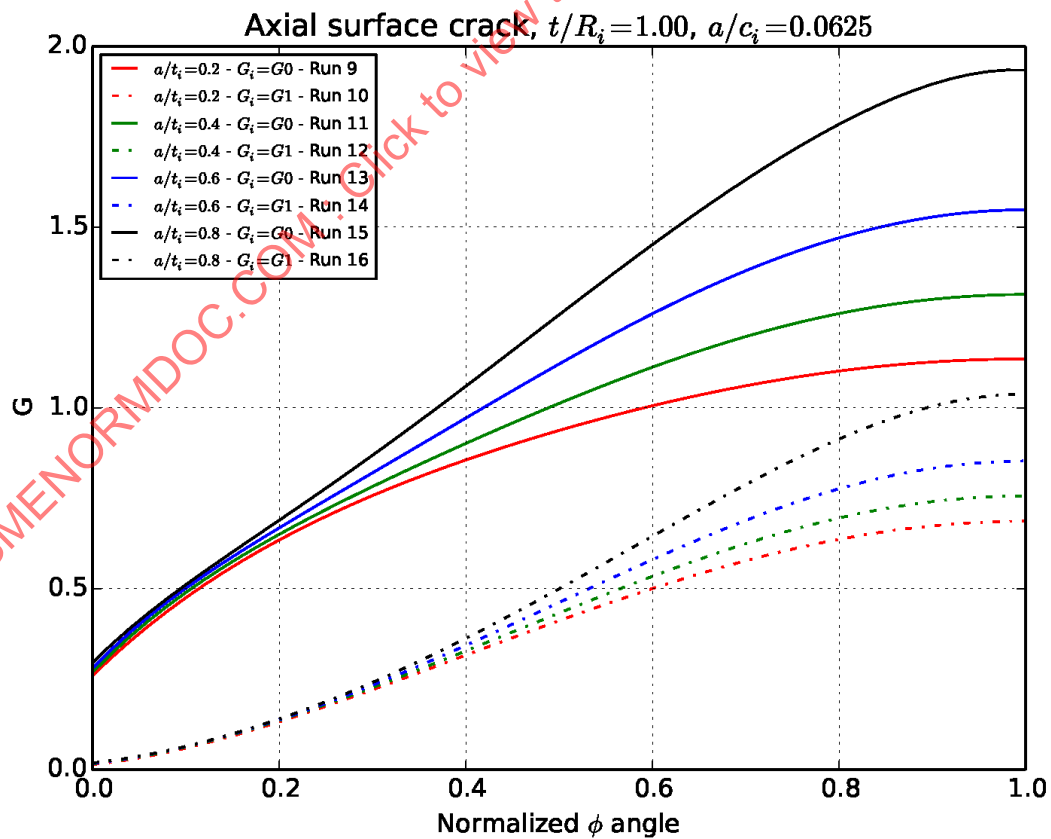
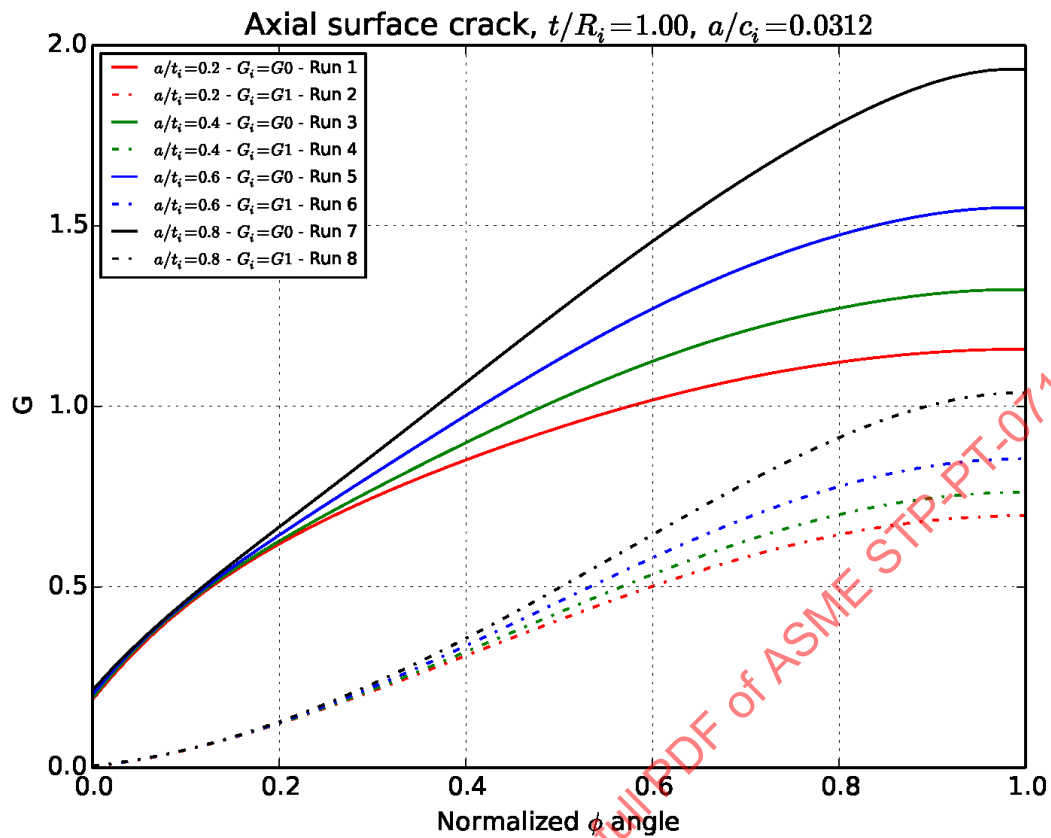
Run ID	Y=OD/ID	t/Ri	a/t	Gi	A0
1136	2.5	1.5	0.8	G0	1.41221858
1137	2.5	1.5	0.8	G1	0.85680073
1138	2.5	1.5	0.8	G2	0.64504053
1139	2.5	1.5	0.8	G3	0.52983435
1140	2.5	1.5	0.8	G4	0.45630272
1141	3	2	0.2	G0	0.96030349
1142	3	2	0.2	G1	0.62323508
1143	3	2	0.2	G2	0.49291409
1144	3	2	0.2	G3	0.41988257
1145	3	2	0.2	G4	0.37179030
1146	3	2	0.4	G0	0.94215135
1147	3	2	0.4	G1	0.62114484
1148	3	2	0.4	G2	0.49339510
1149	3	2	0.4	G3	0.42092469
1150	3	2	0.4	G4	0.37291850
1151	3	2	0.6	G0	1.02580757
1152	3	2	0.6	G1	0.66624804
1153	3	2	0.6	G2	0.52310457
1154	3	2	0.6	G3	0.44247272
1155	3	2	0.6	G4	0.38949429
1156	3	2	0.8	G0	1.32737142
1157	3	2	0.8	G1	0.82651408
1158	3	2	0.8	G2	0.62897730
1159	3	2	0.8	G3	0.51968160
1160	3	2	0.8	G4	0.44920993
1161	3.5	2.5	0.2	G0	0.92916558
1162	3.5	2.5	0.2	G1	0.61137646
1163	3.5	2.5	0.2	G2	0.48631623
1164	3.5	2.5	0.2	G3	0.41555239
1165	3.5	2.5	0.2	G4	0.36867005
1166	3.5	2.5	0.4	G0	0.90337333
1167	3.5	2.5	0.4	G1	0.60639294
1168	3.5	2.5	0.4	G2	0.48520507
1169	3.5	2.5	0.4	G3	0.41556344
1170	3.5	2.5	0.4	G4	0.36906662
1171	3.5	2.5	0.6	G0	0.98016940
1172	3.5	2.5	0.6	G1	0.64922203
1173	3.5	2.5	0.6	G2	0.51377935
1174	3.5	2.5	0.6	G3	0.43642982
1175	3.5	2.5	0.6	G4	0.38518705
1176	3.5	2.5	0.8	G0	1.26947796
1177	3.5	2.5	0.8	G1	0.80578141
1178	3.5	2.5	0.8	G2	0.61796081
1179	3.5	2.5	0.8	G3	0.51271043

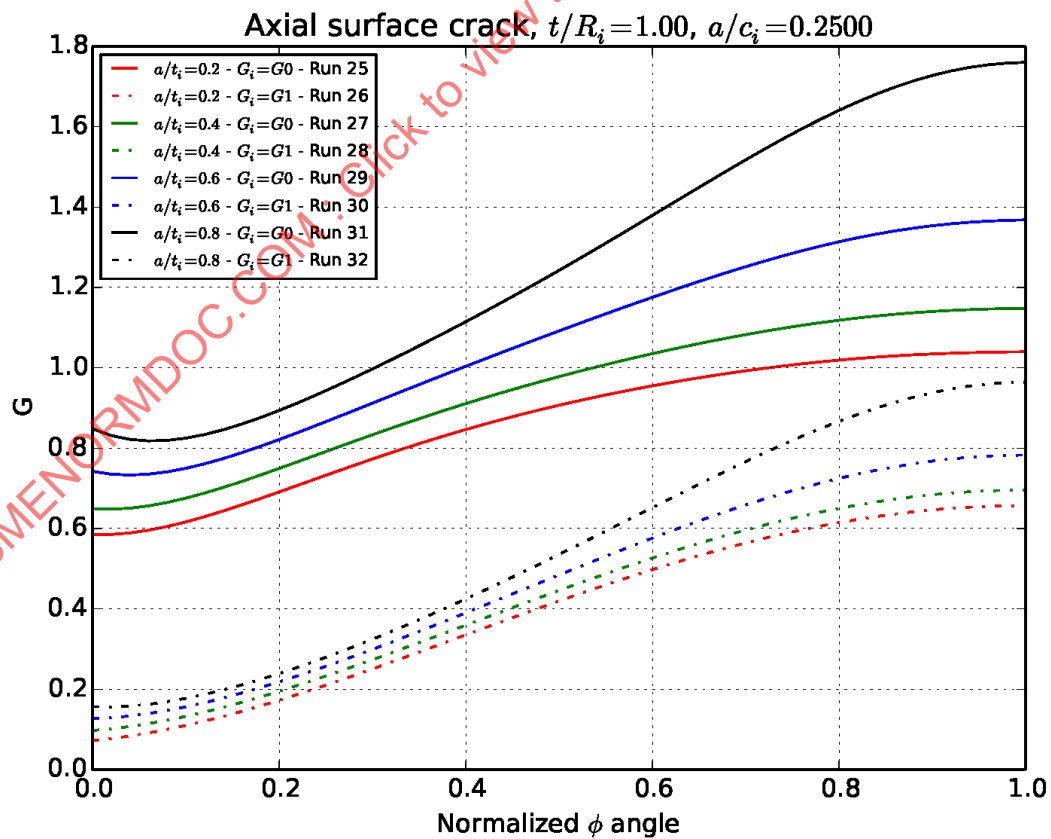
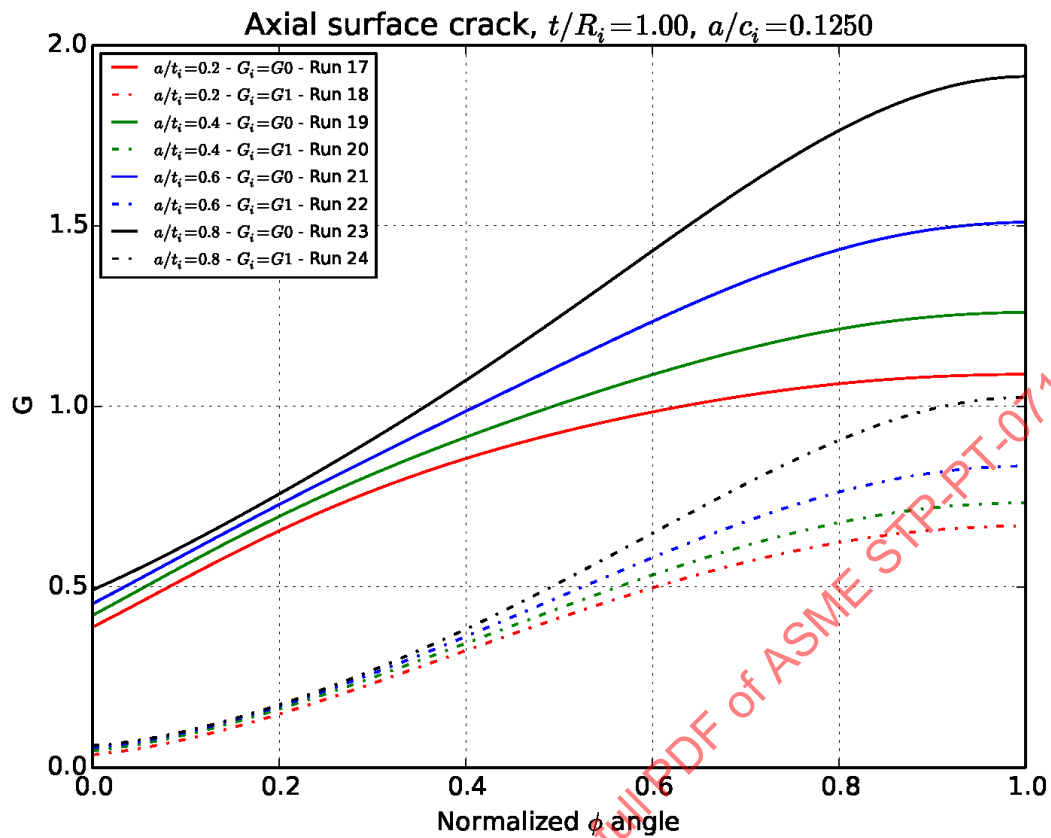
Run ID	Y=OD/ID	t/Ri	a/t	Gi	A0
1180	3.5	2.5	0.8	G4	0.44433609
1181	4	3	0.2	G0	0.90386077
1182	4	3	0.2	G1	0.60173851
1183	4	3	0.2	G2	0.48095567
1184	4	3	0.2	G3	0.41203638
1185	4	3	0.2	G4	0.36613870
1186	4	3	0.4	G0	0.87424105
1187	4	3	0.4	G1	0.59528857
1188	4	3	0.4	G2	0.47903464
1189	4	3	0.4	G3	0.41152256
1190	4	3	0.4	G4	0.36616299
1191	4	3	0.6	G0	0.94689026
1192	4	3	0.6	G1	0.63677115
1193	4	3	0.6	G2	0.50694975
1194	4	3	0.6	G3	0.43200024
1195	4	3	0.6	G4	0.38202806
1196	4	3	0.8	G0	1.22731682
1197	4	3	0.8	G1	0.79064860
1198	4	3	0.8	G2	0.60990980
1199	4	3	0.8	G3	0.50761178
1200	4	3	0.8	G4	0.44076955

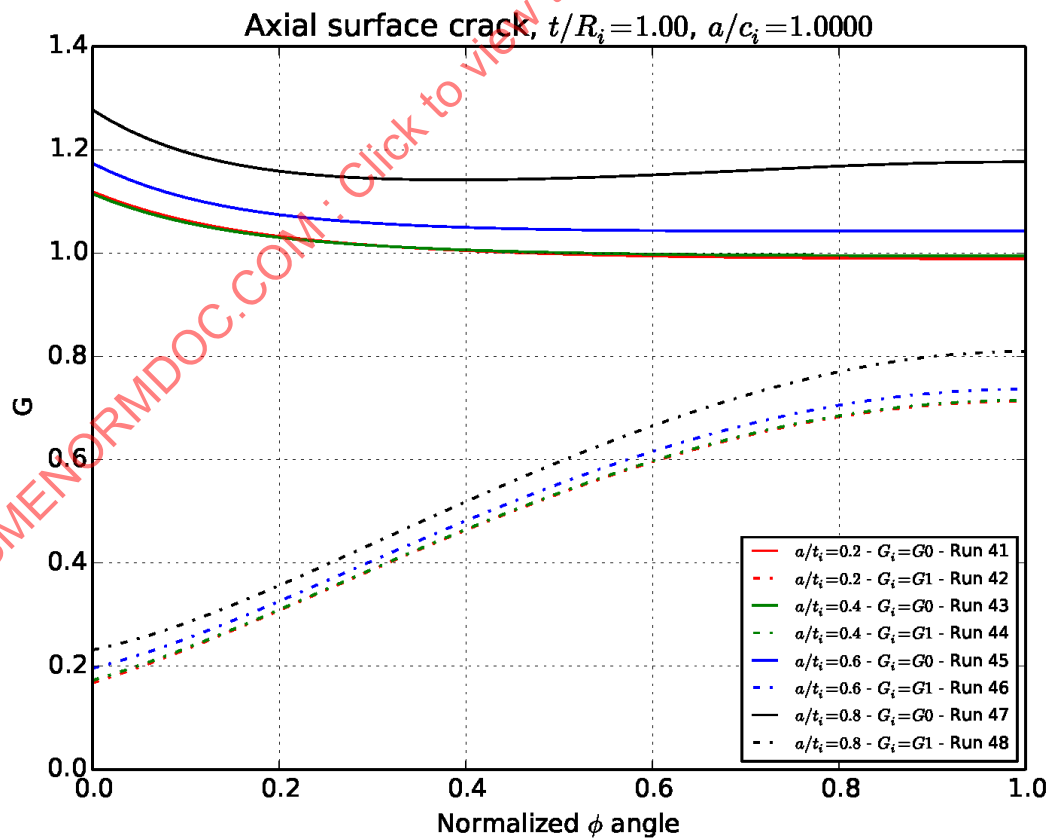
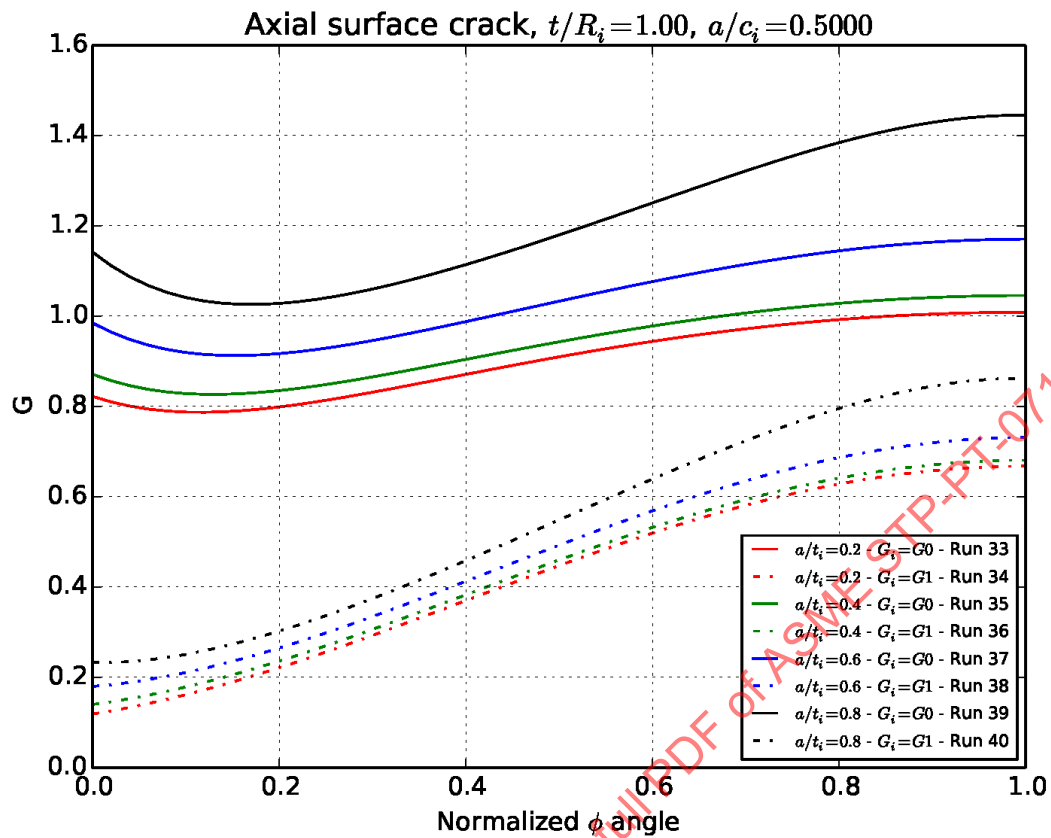
APPENDIX E - AXIAL INTERNAL SURFACE CRACK G RESULT PLOTS

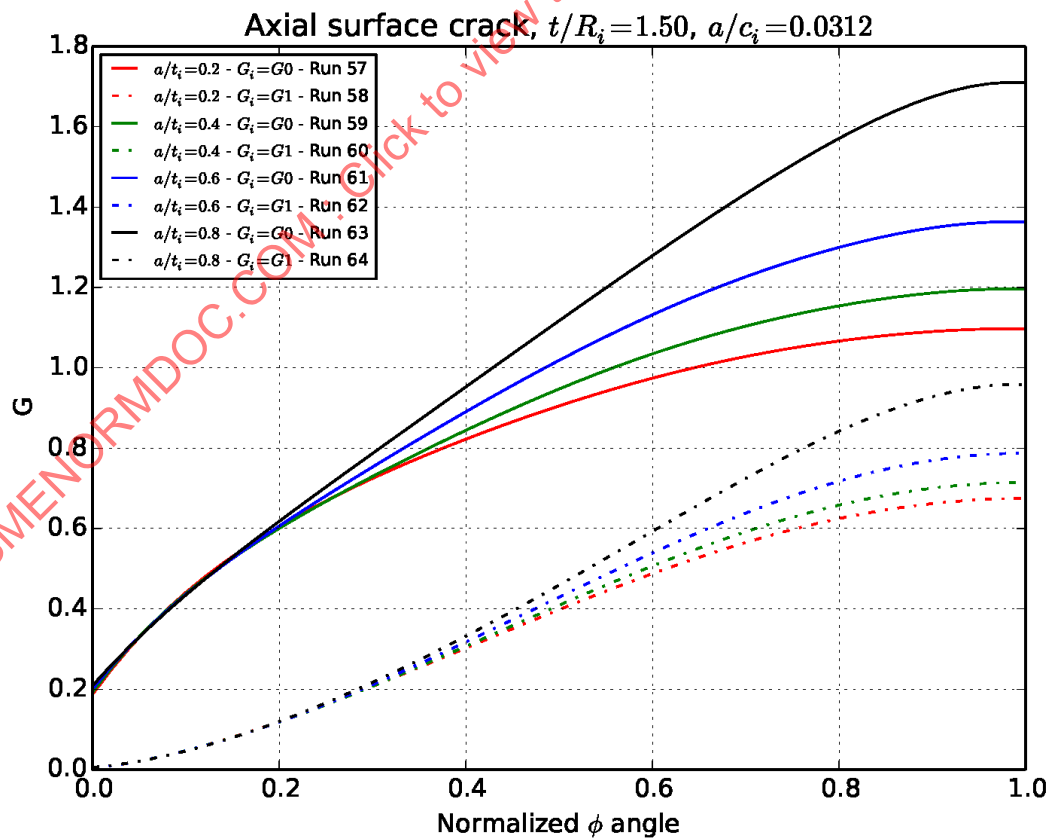
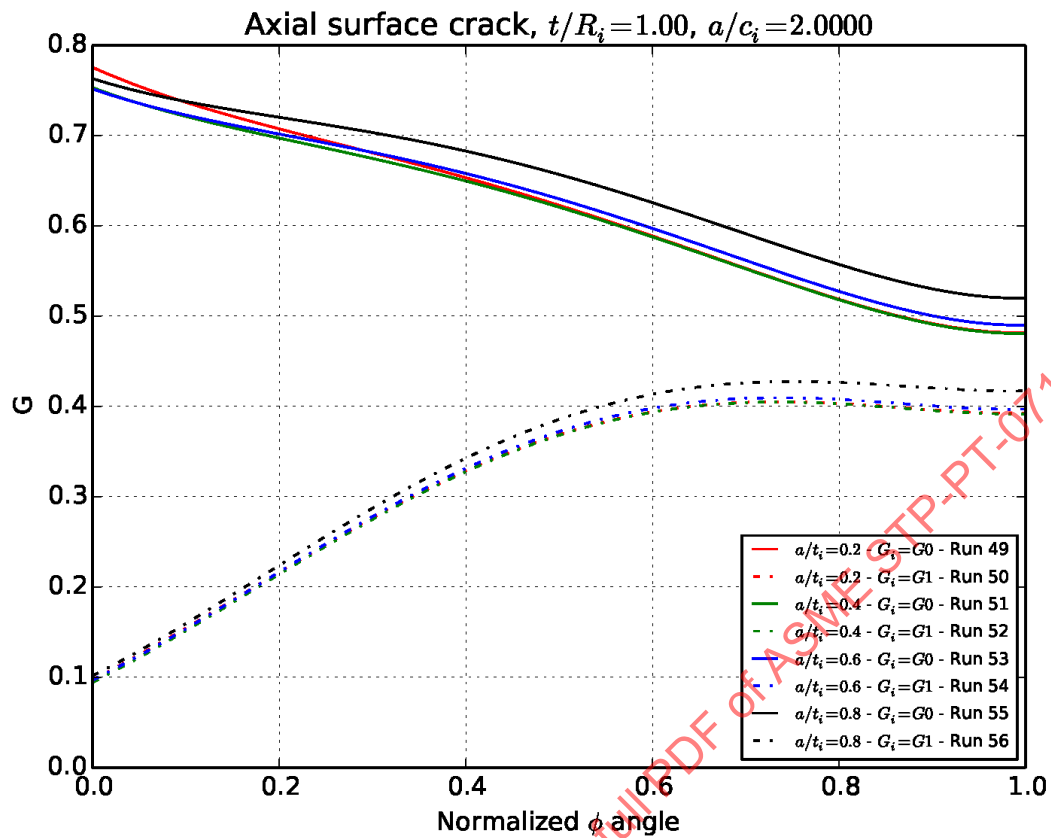
Plots of all the axial internal surface crack cases, G versus the normalized crack front angle position $2\phi/\pi$. Eight curves per plot to show the uniform G_0 and linear G_1 load cases for the four a/t ratios. Each page contains the plot for a particular t/R_i and a/c ratio. 35 plots total.

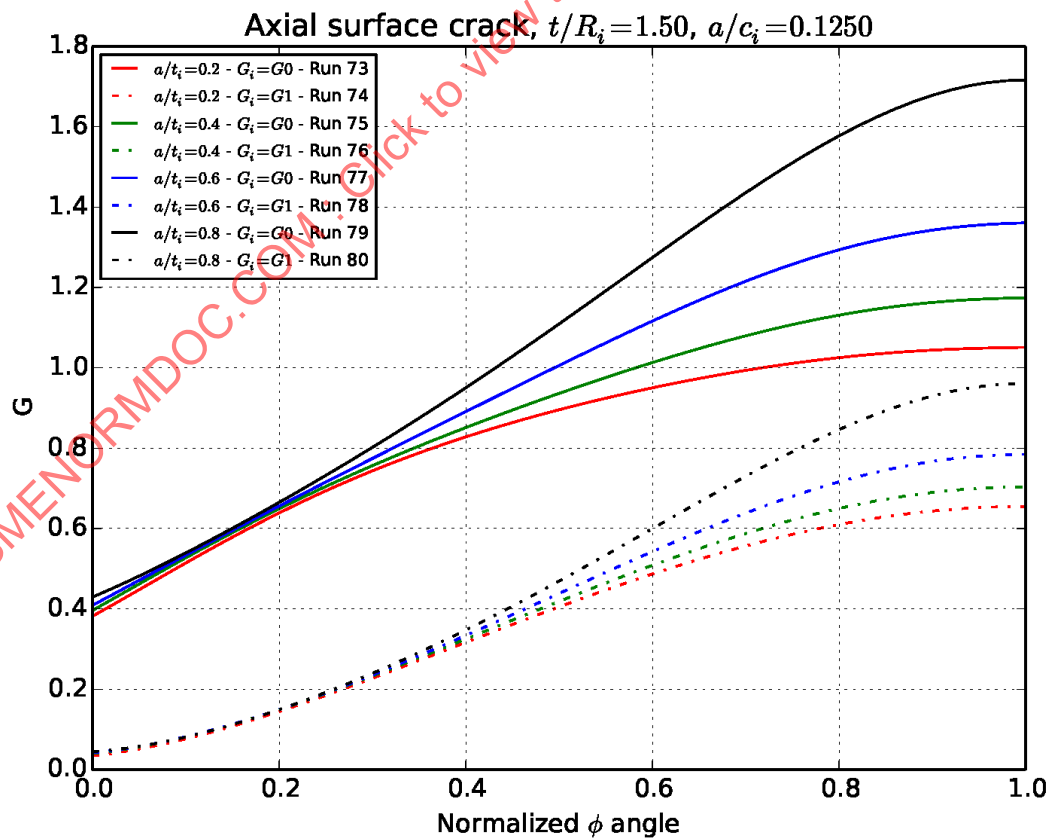
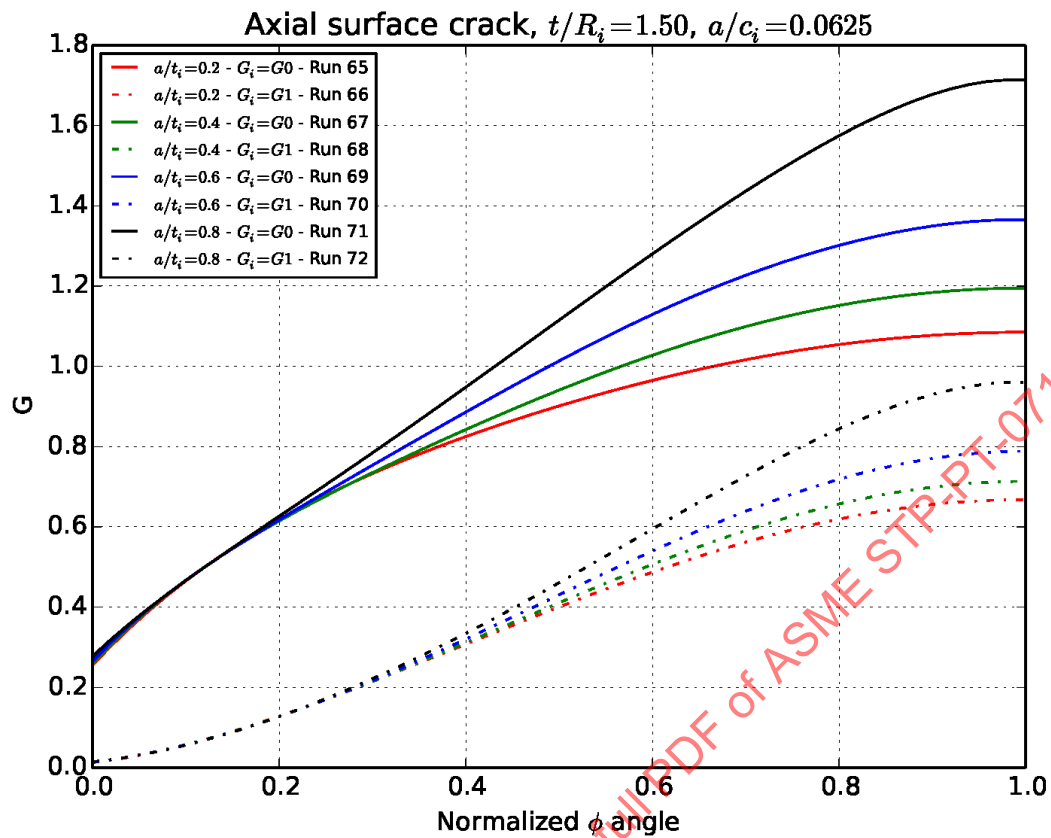
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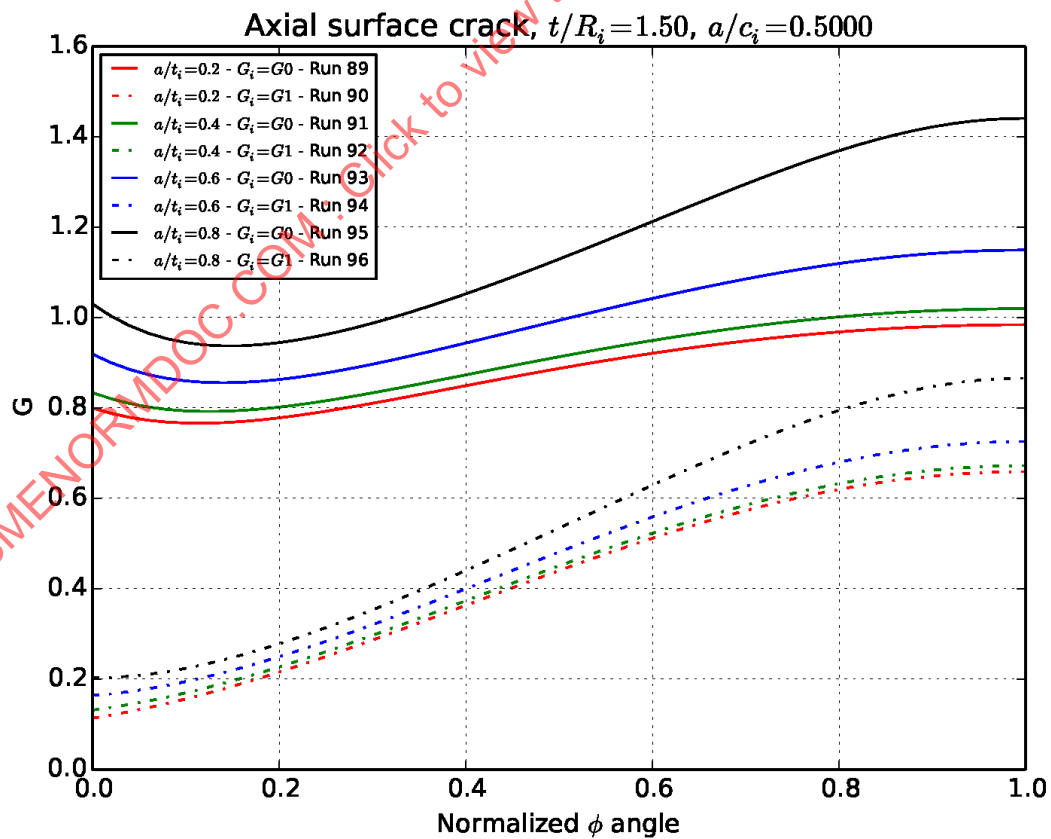
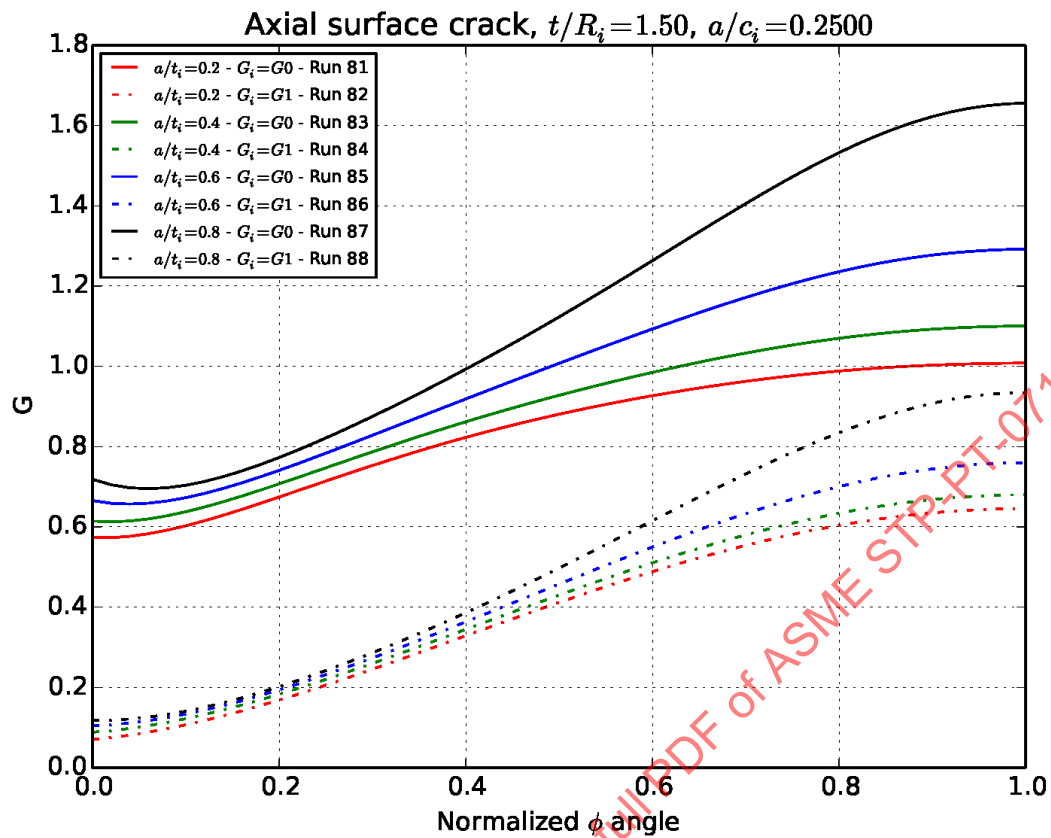


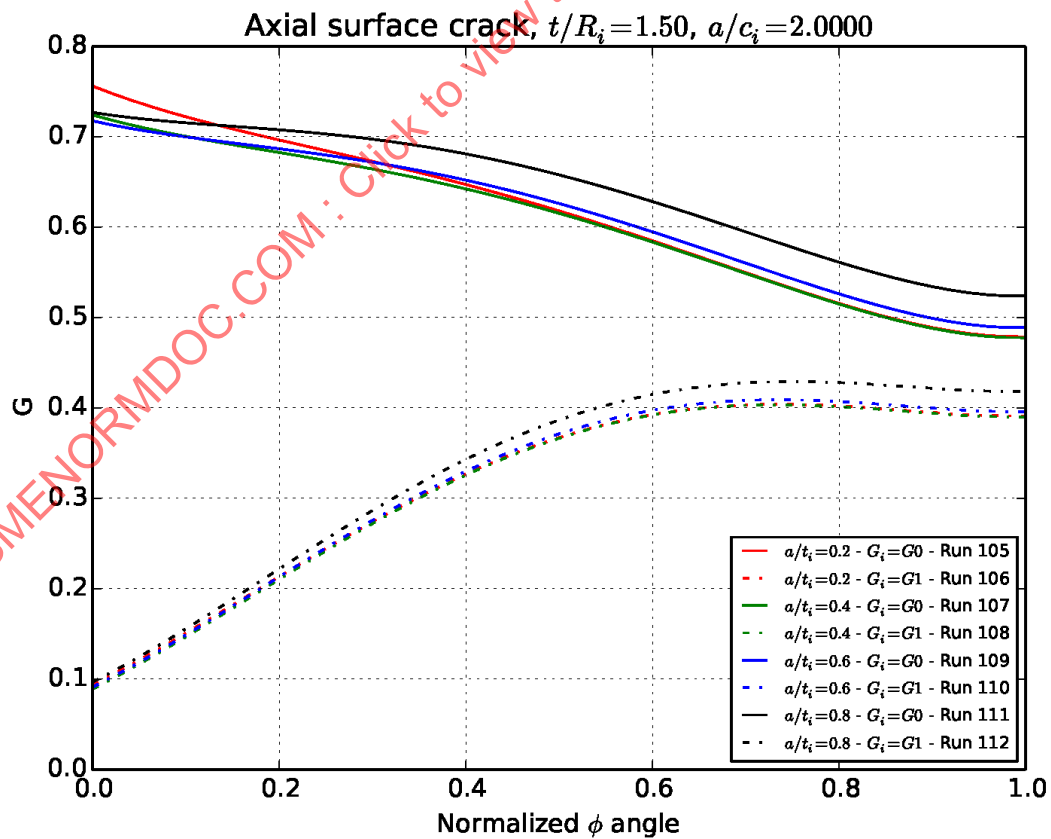
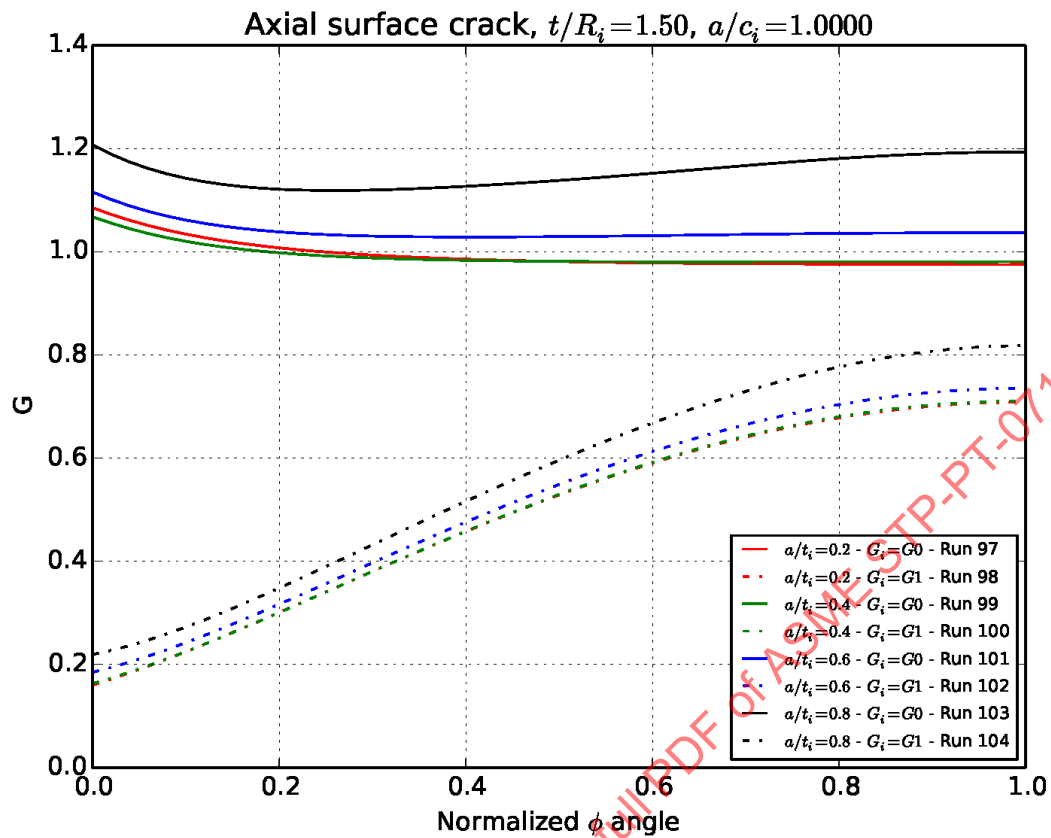


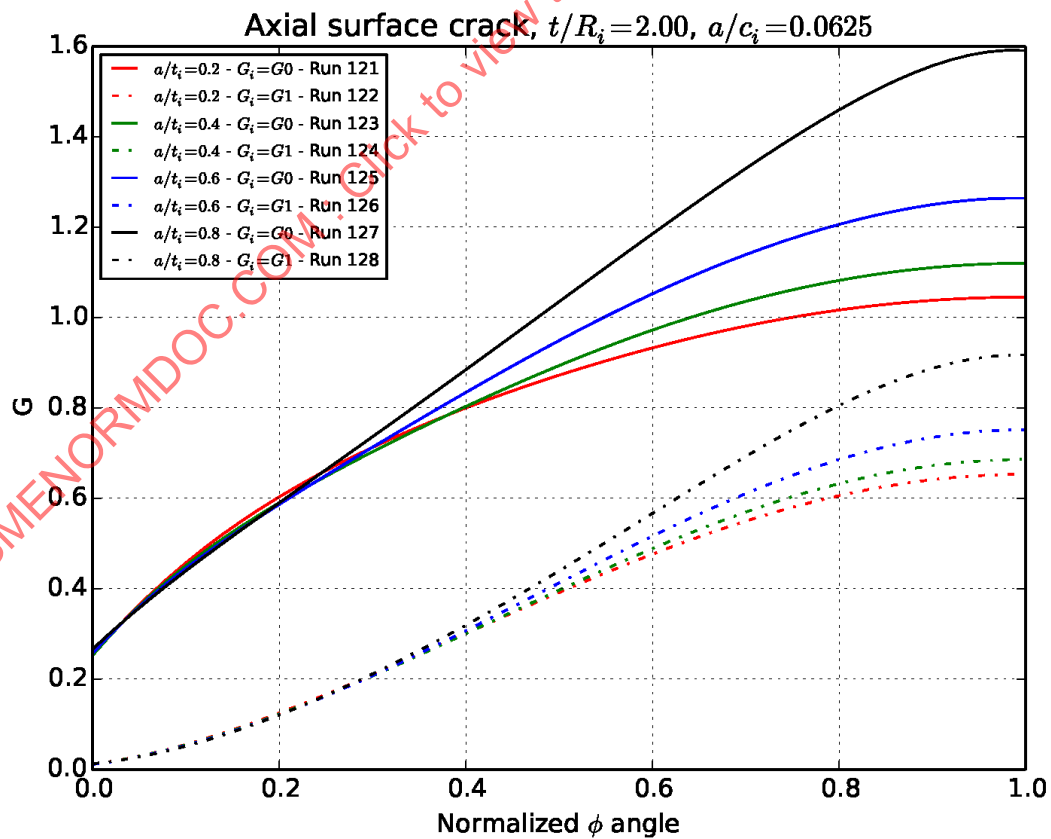
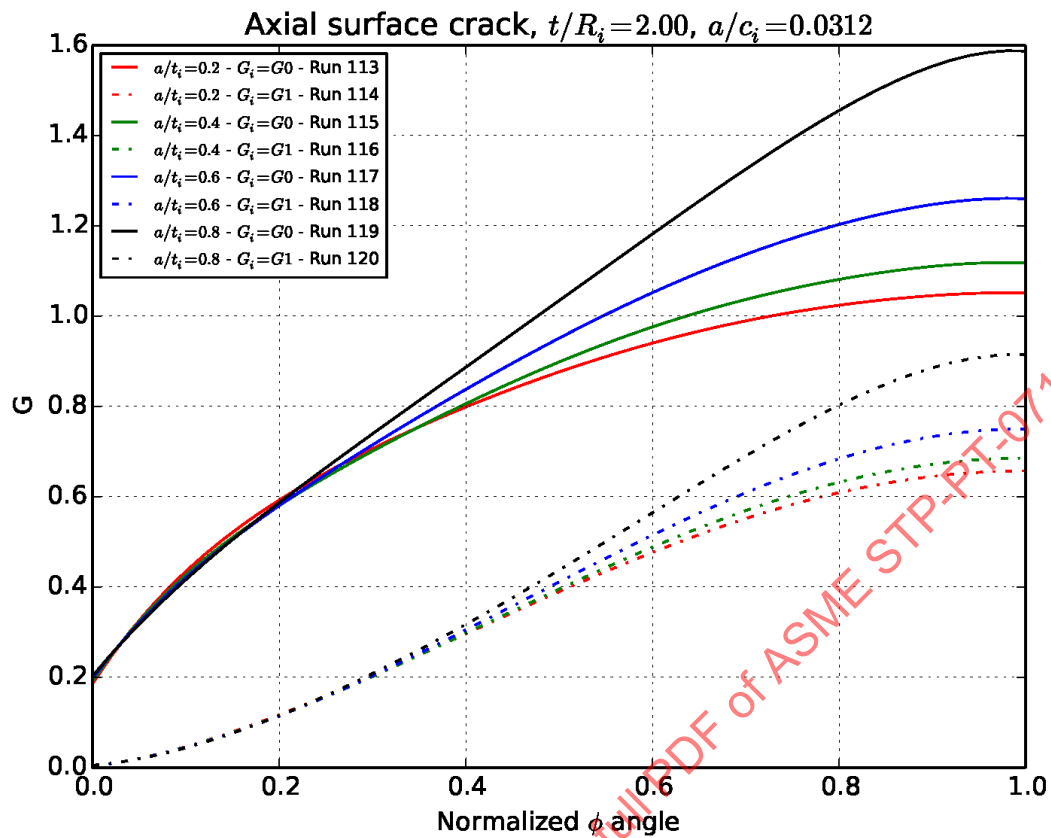


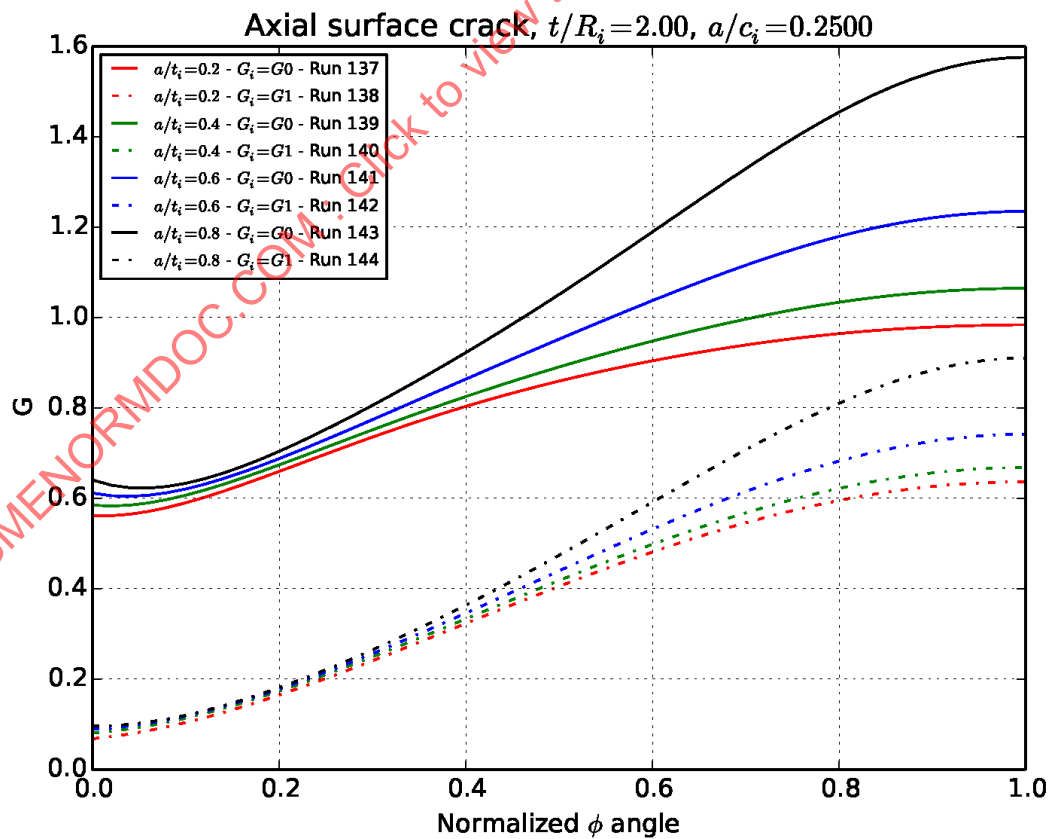
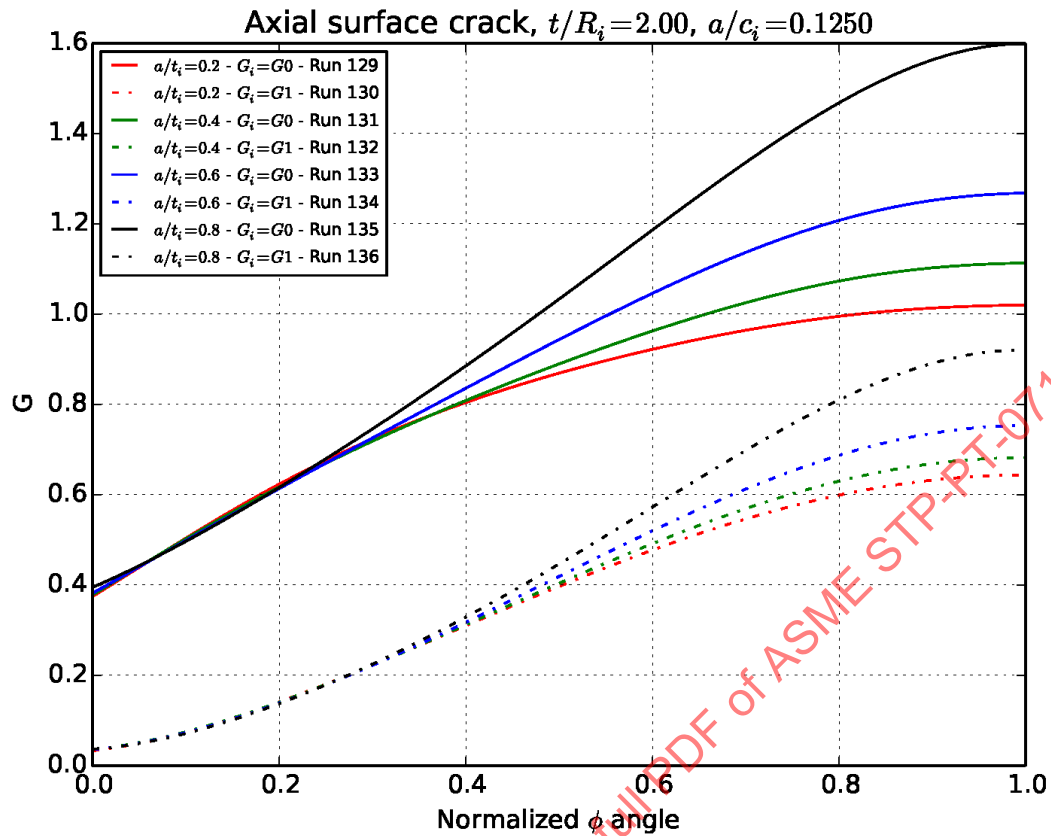


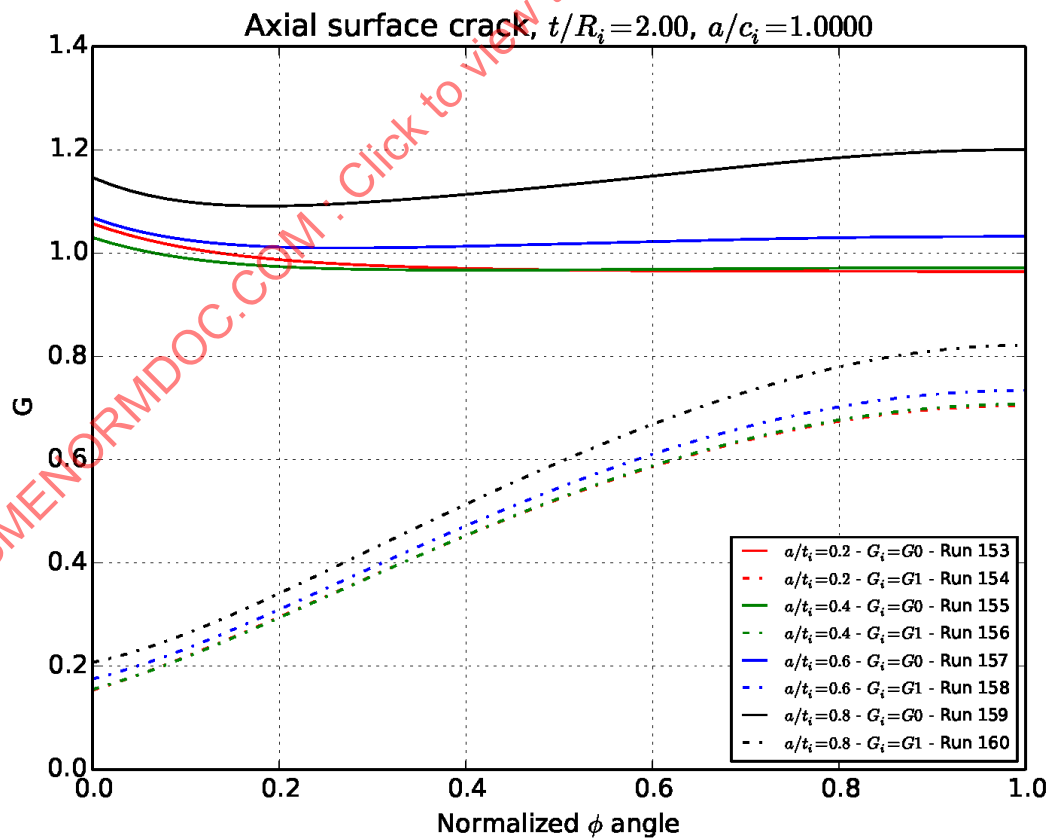
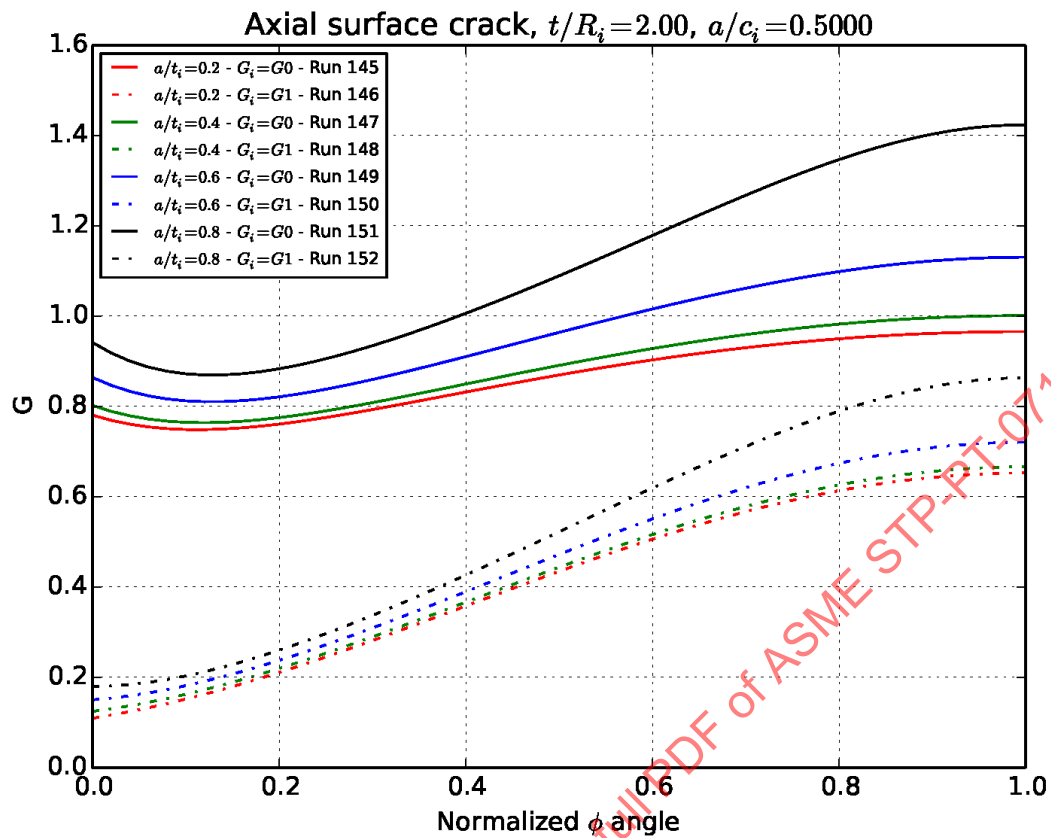


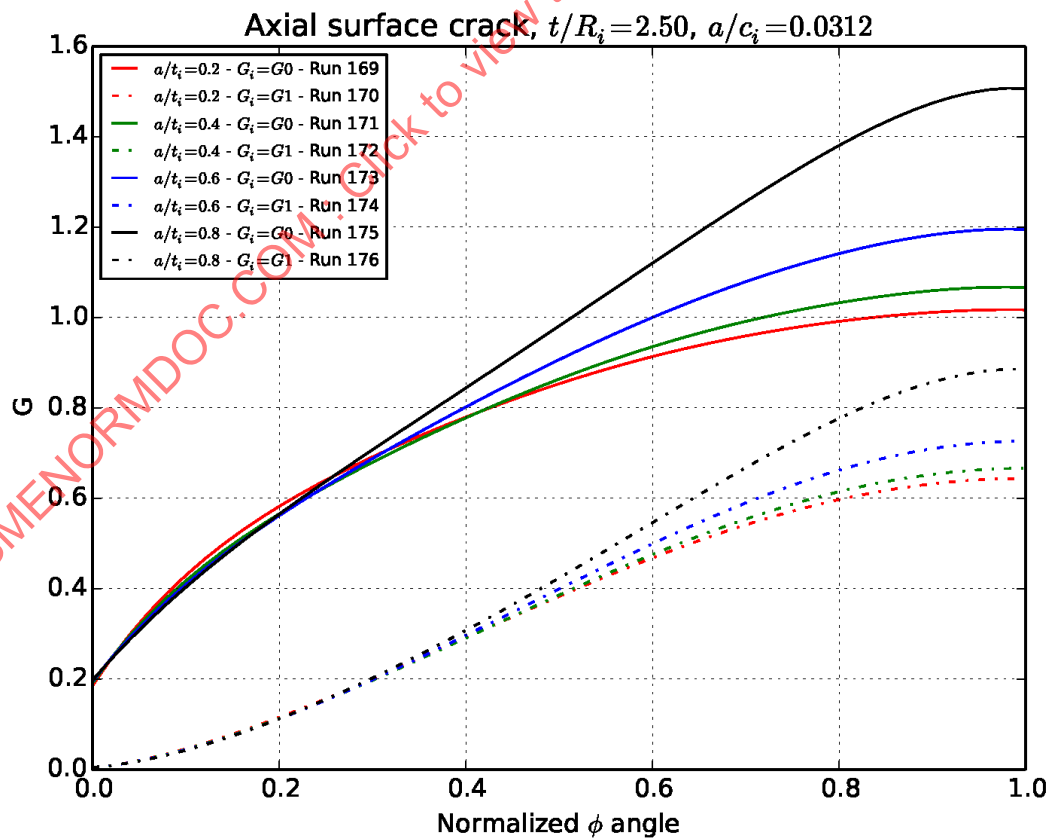
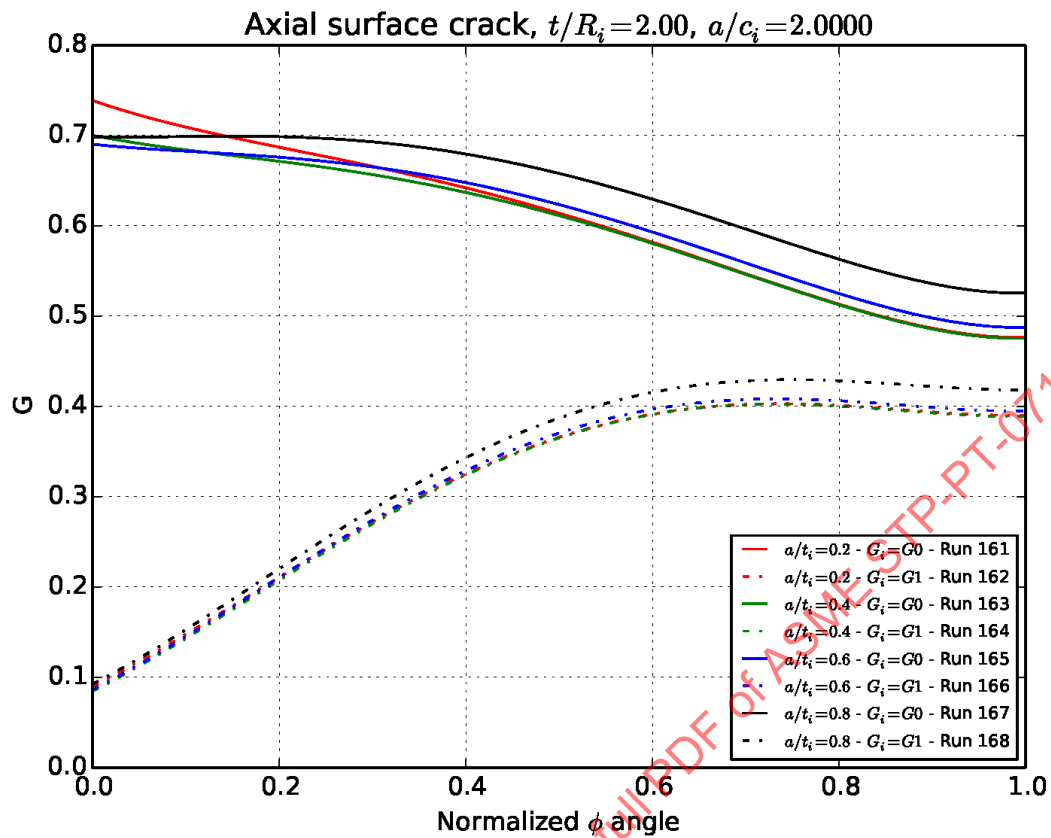


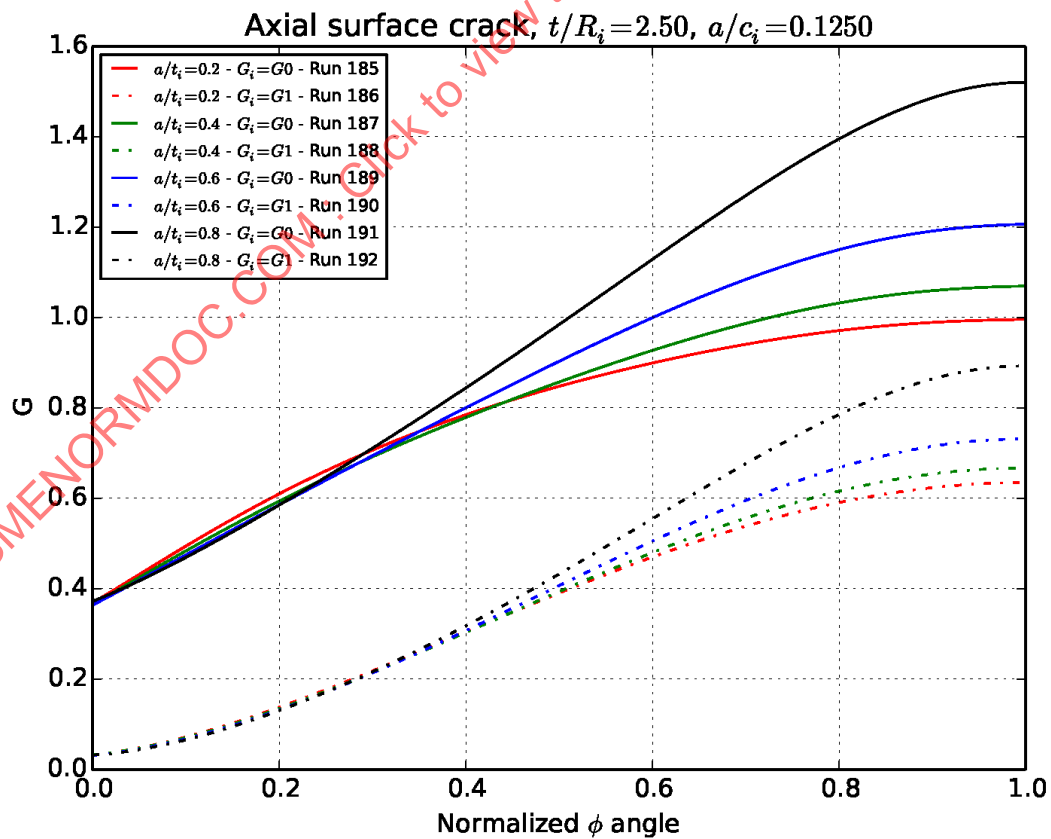
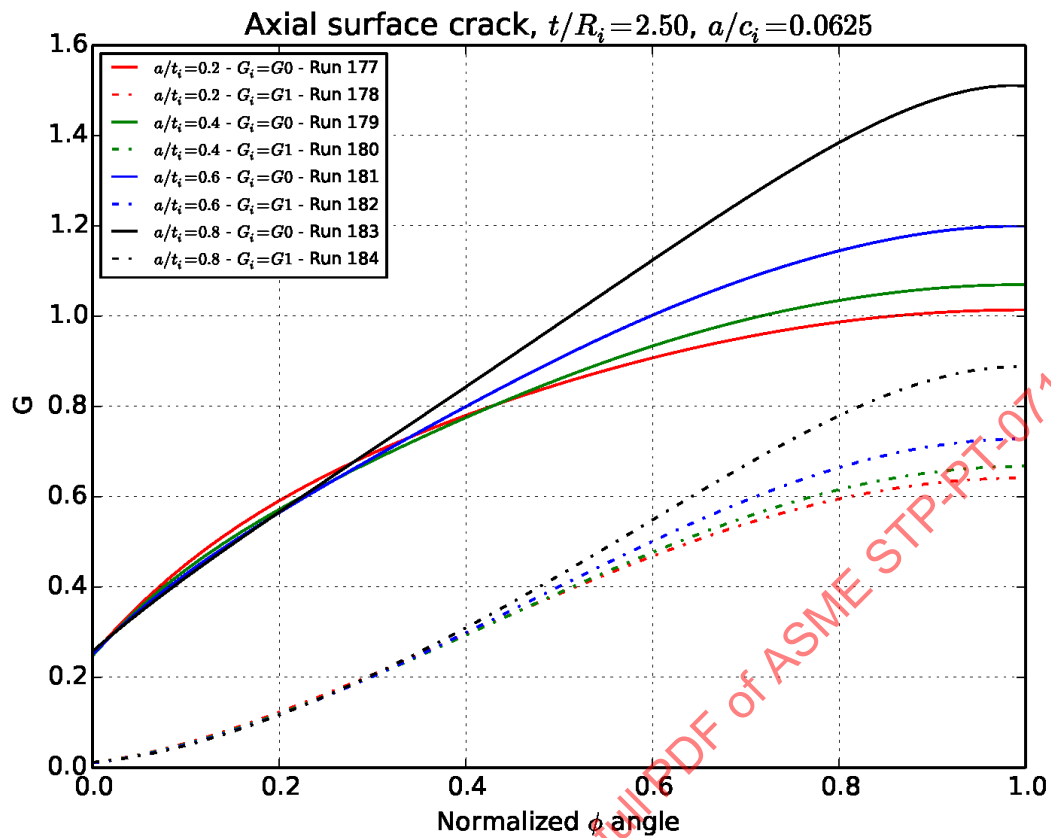


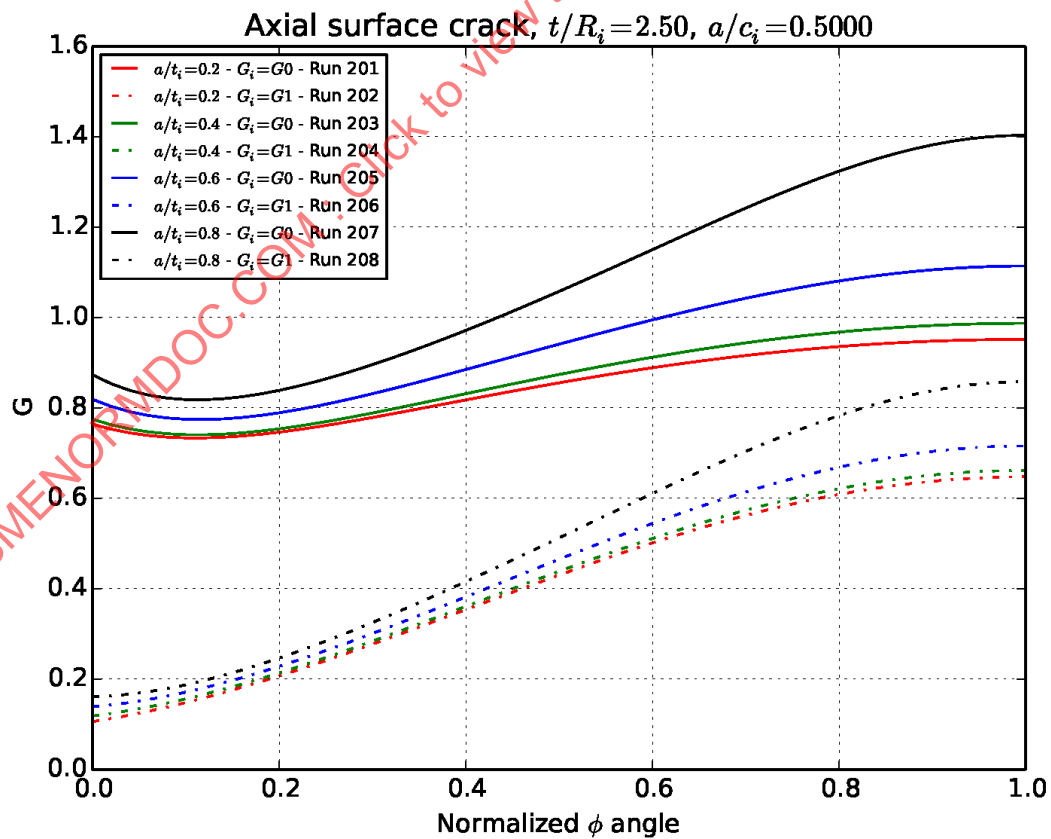
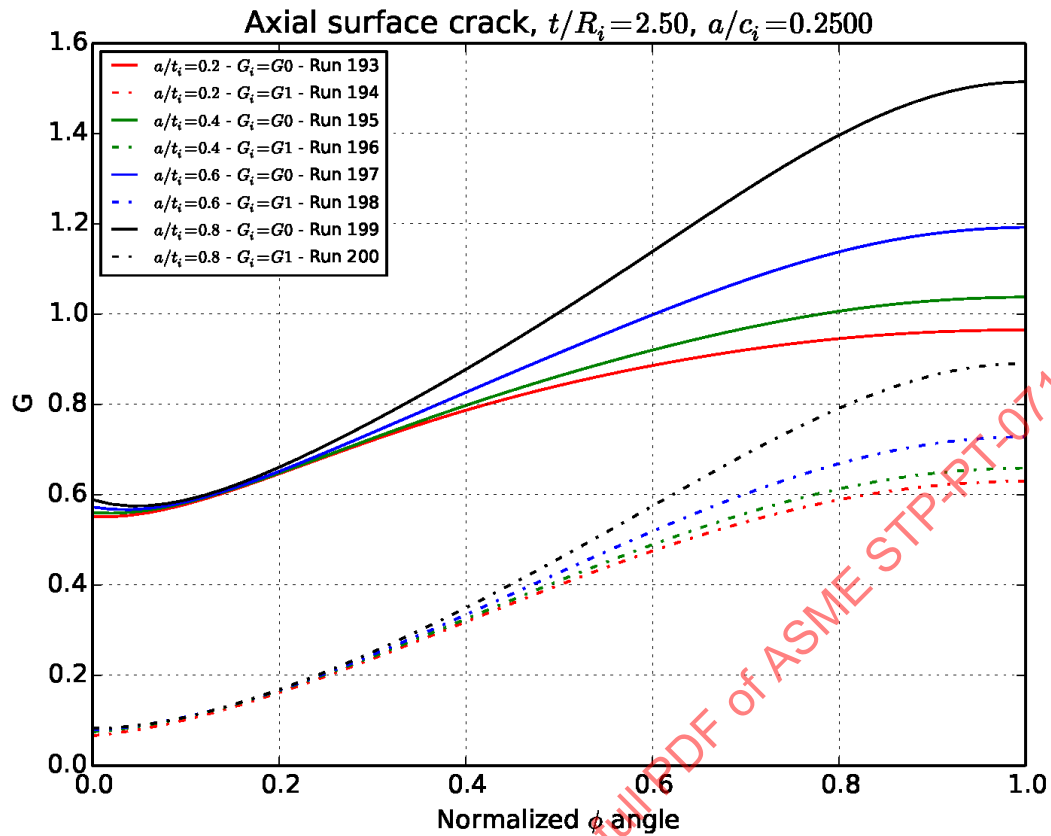


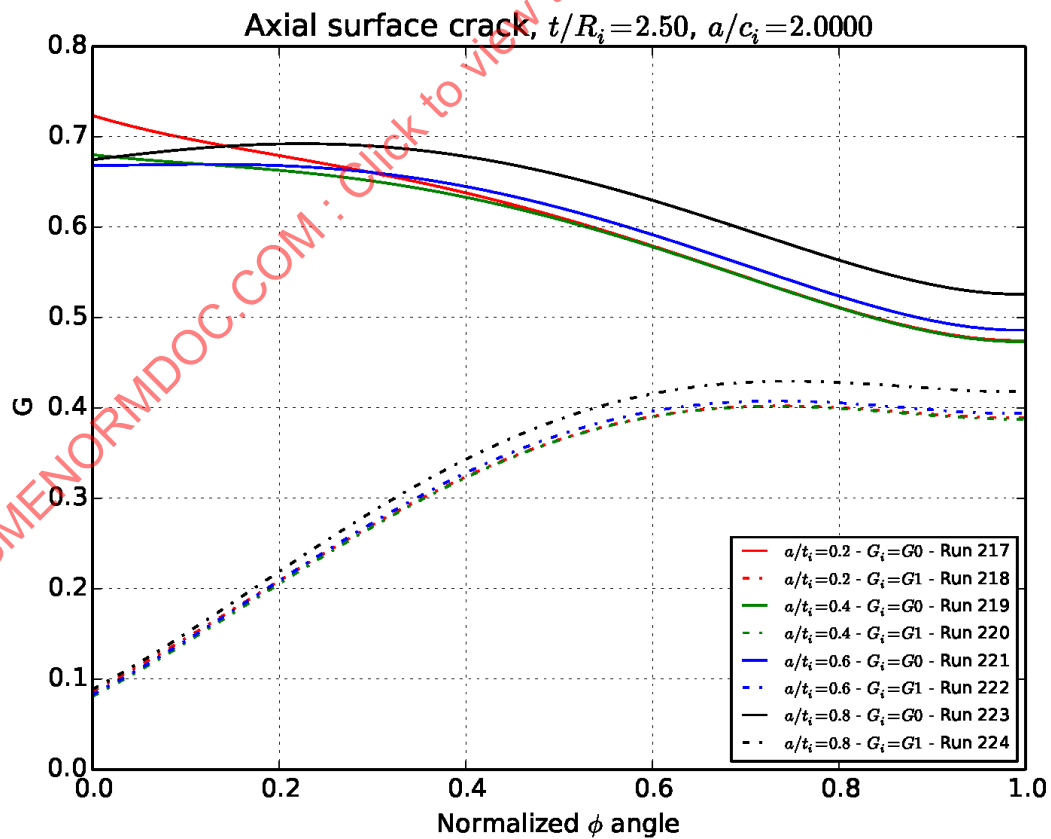
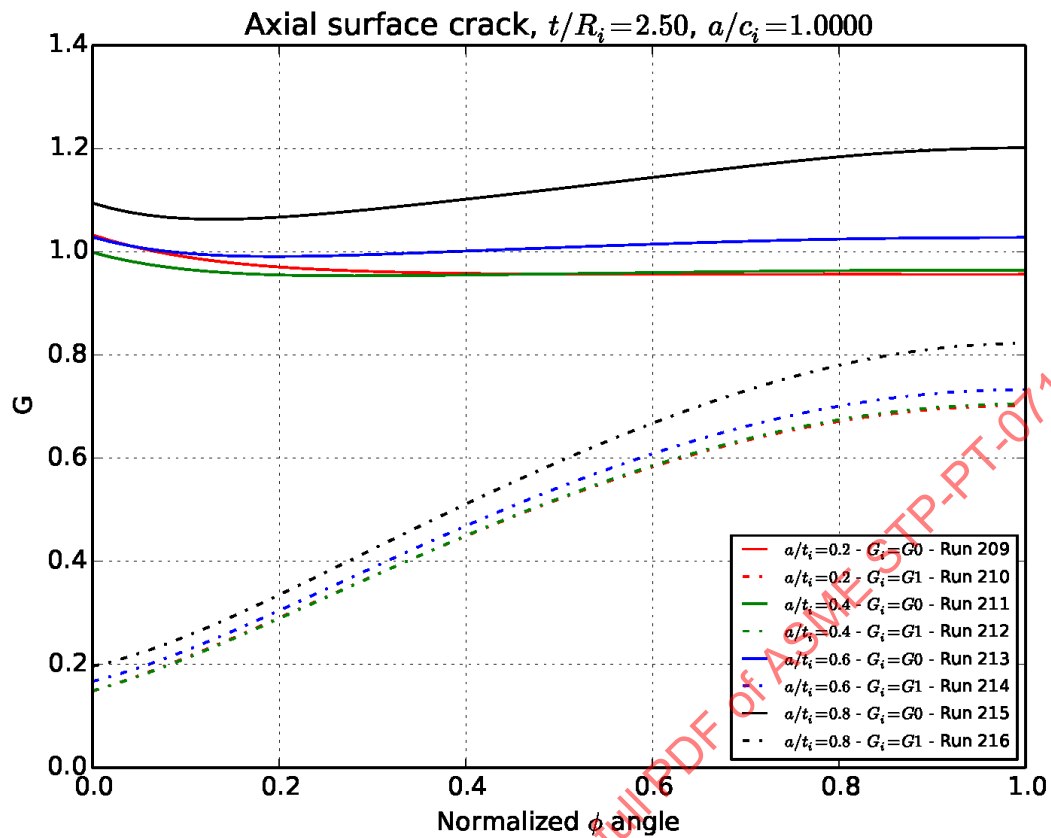


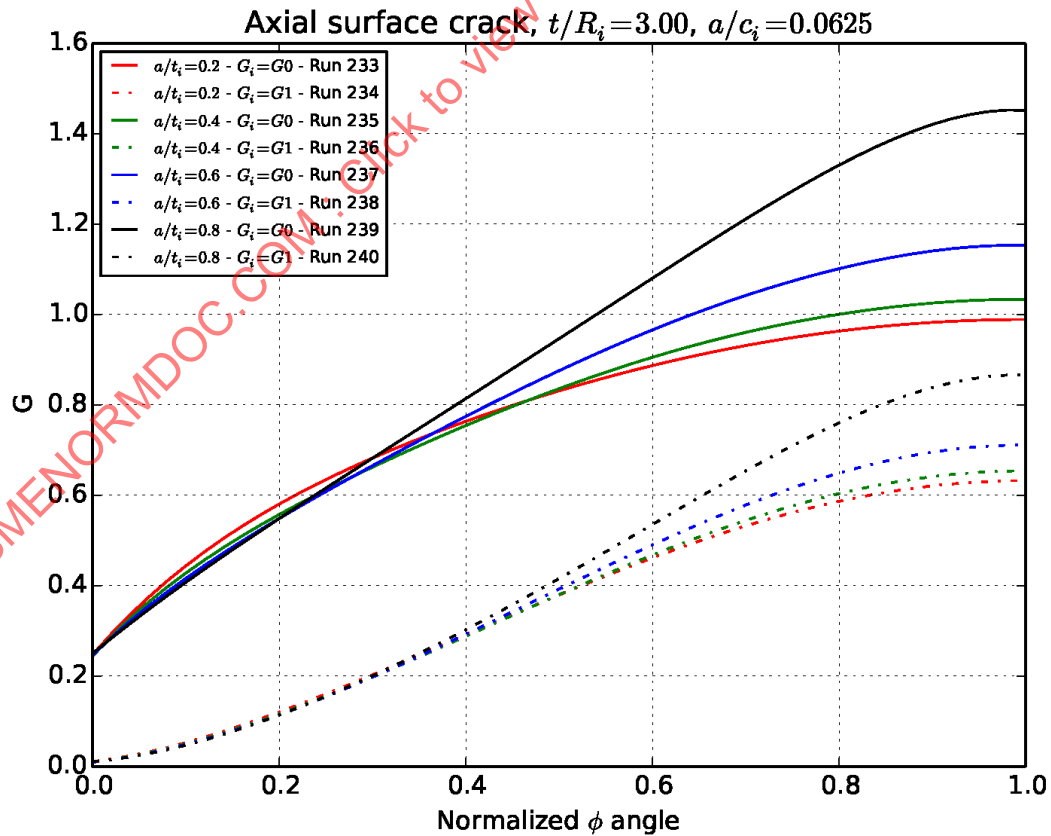
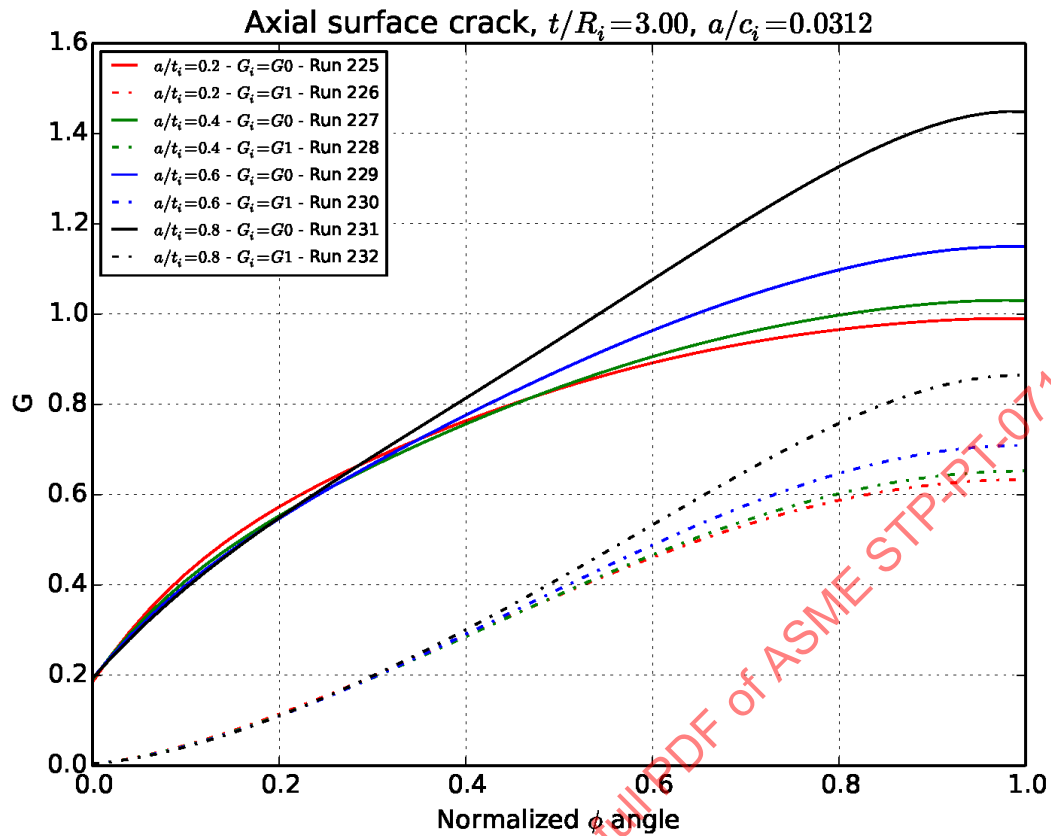


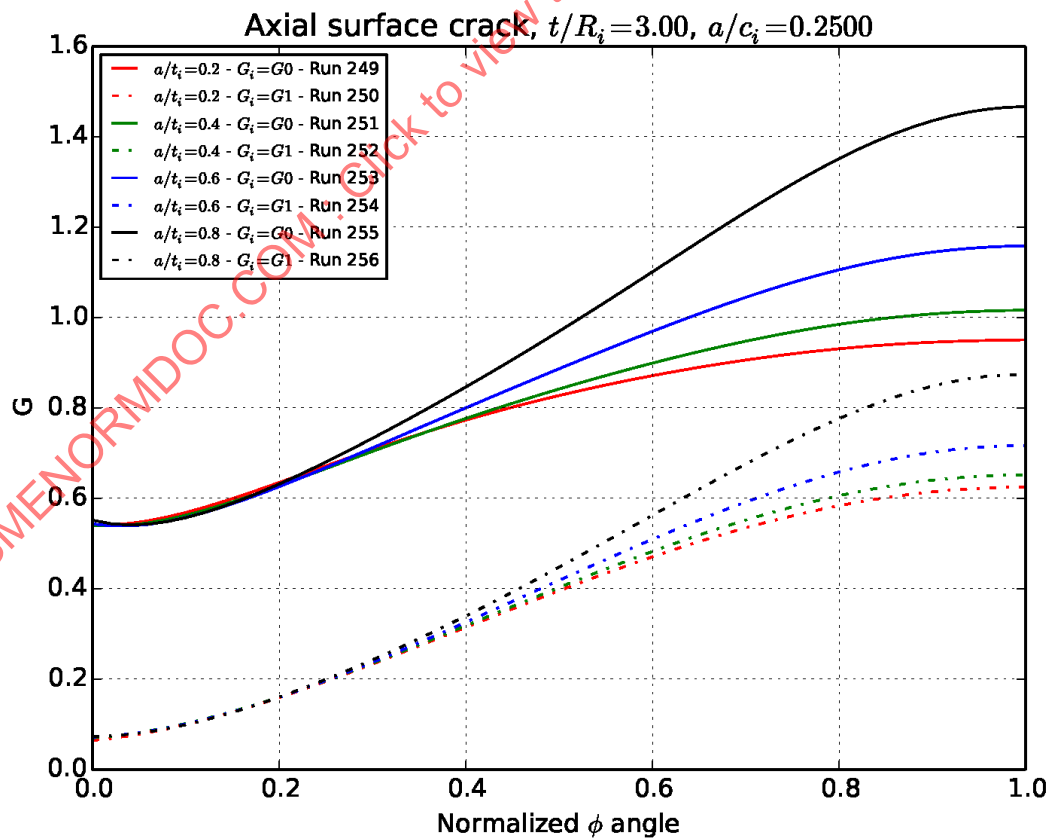
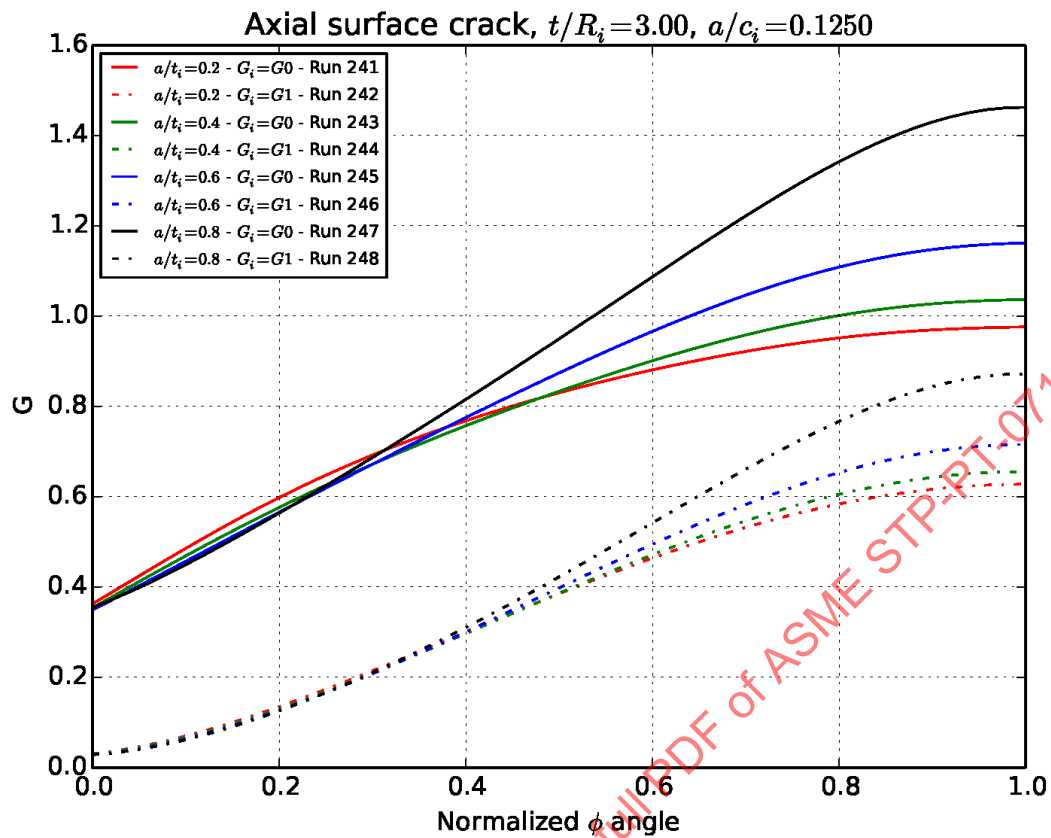


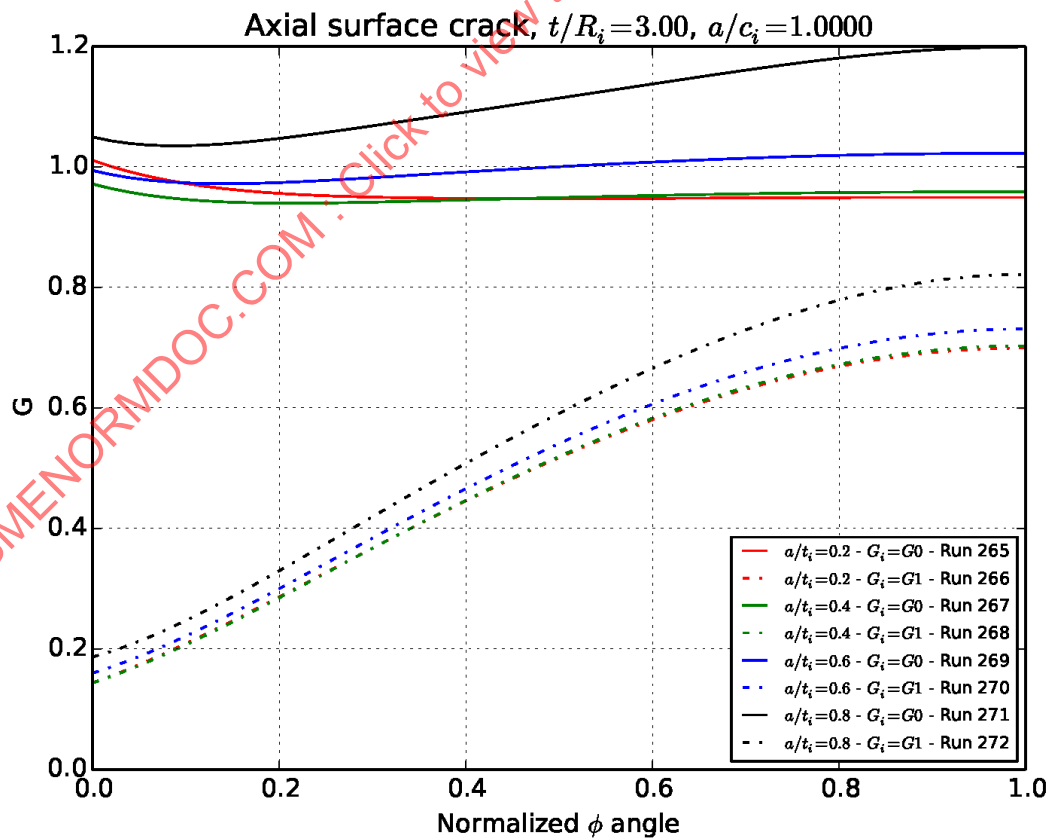
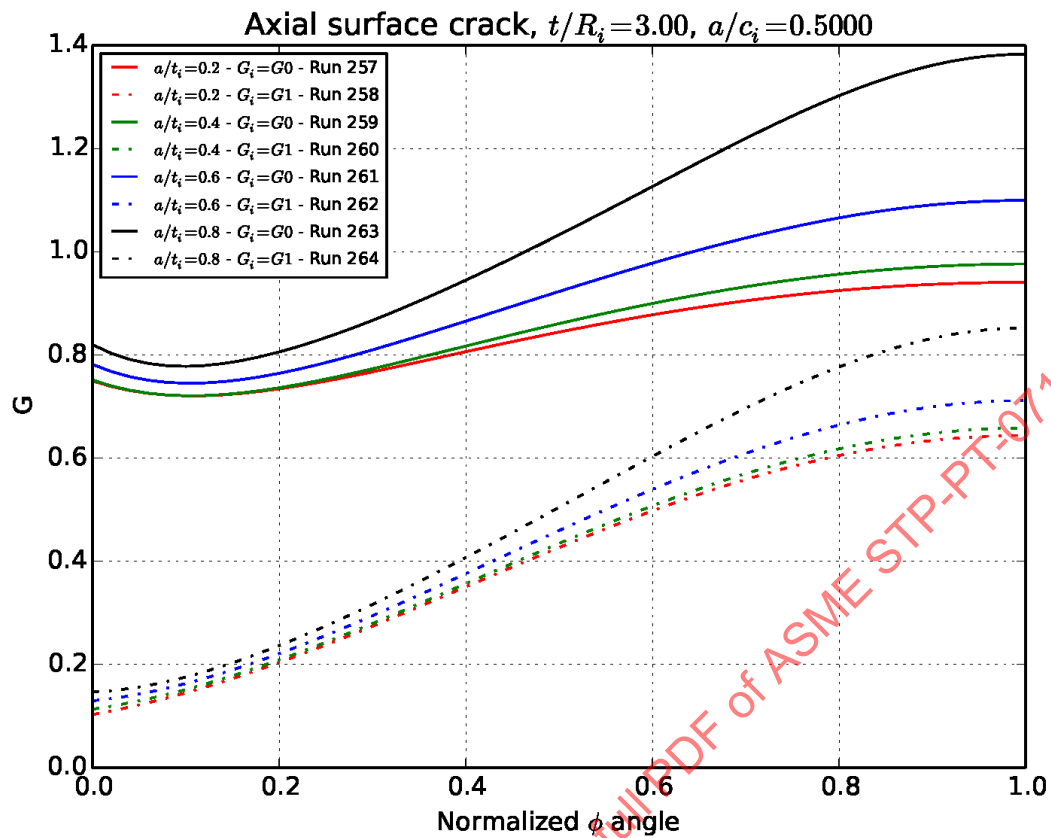


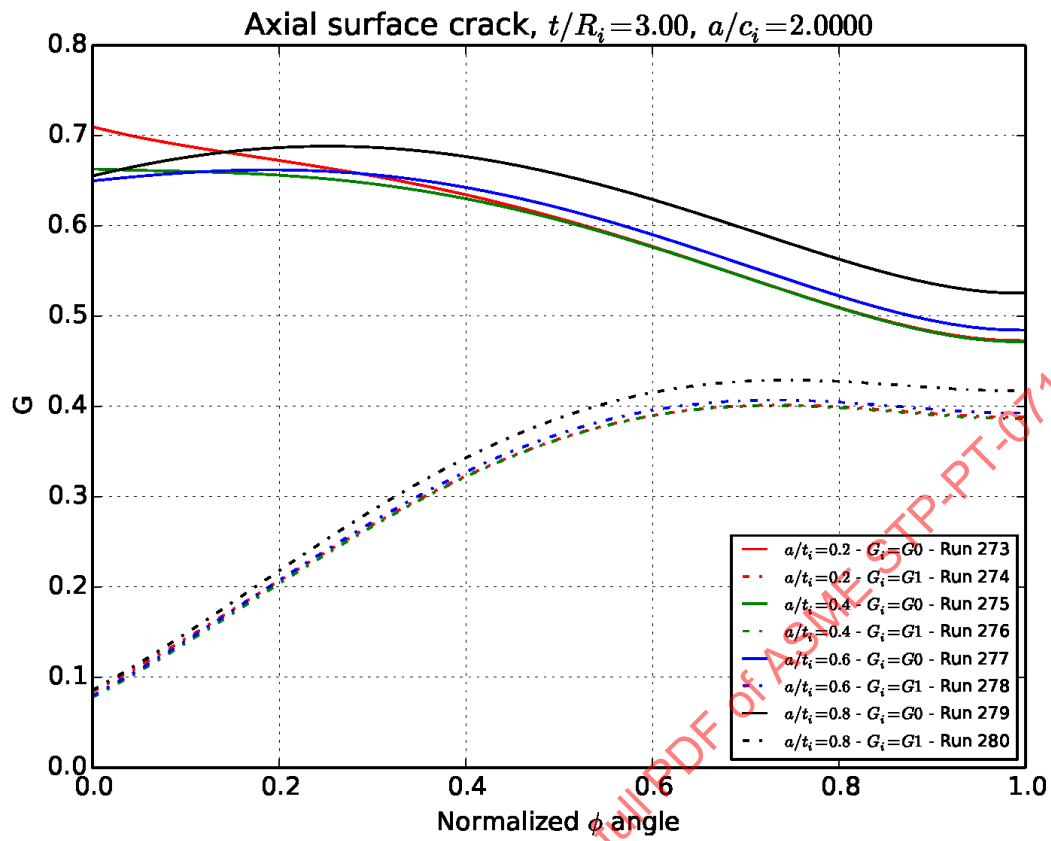








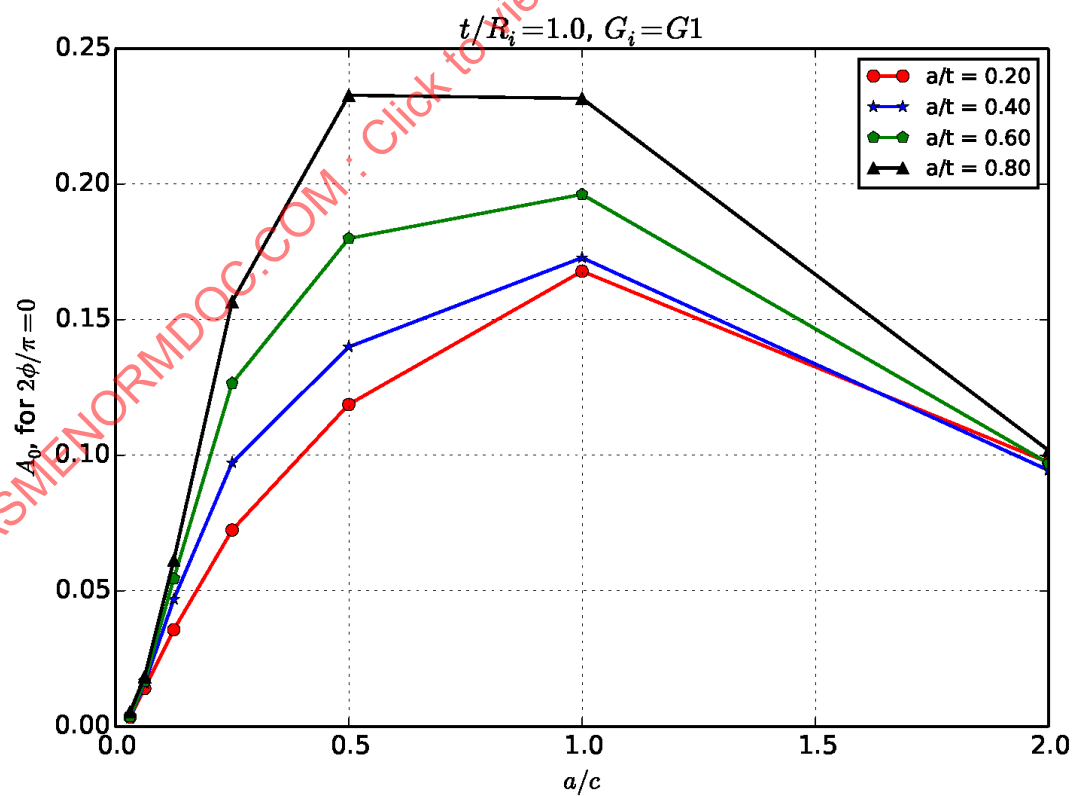
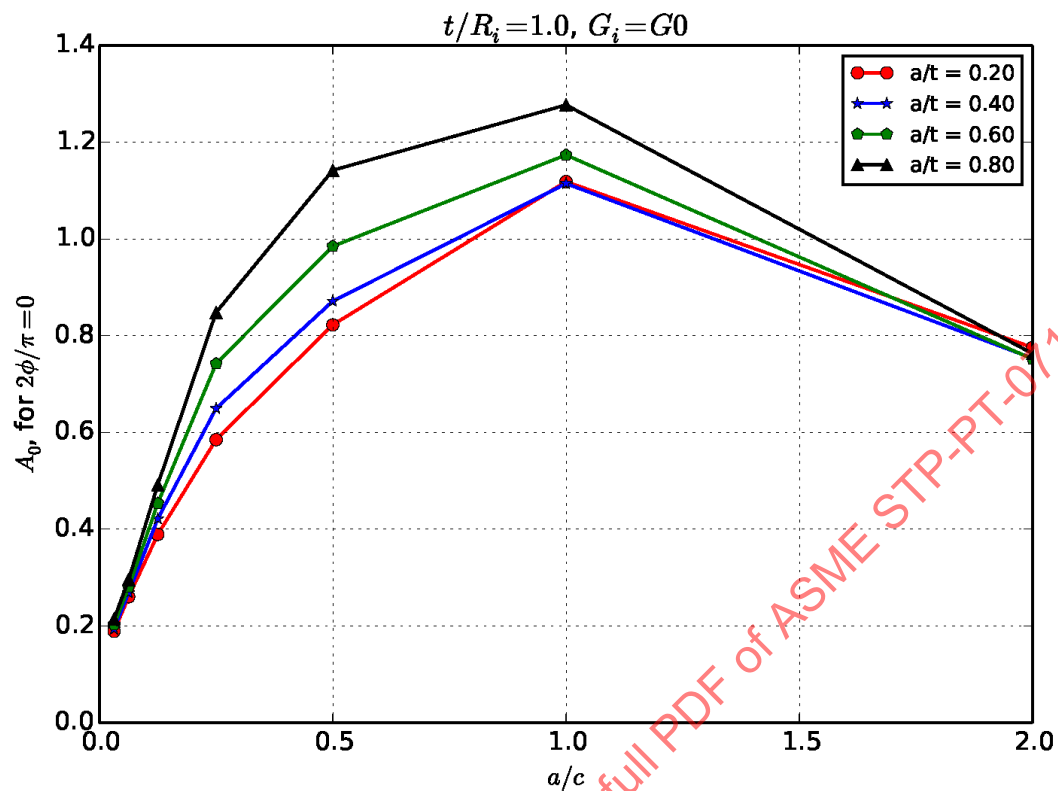


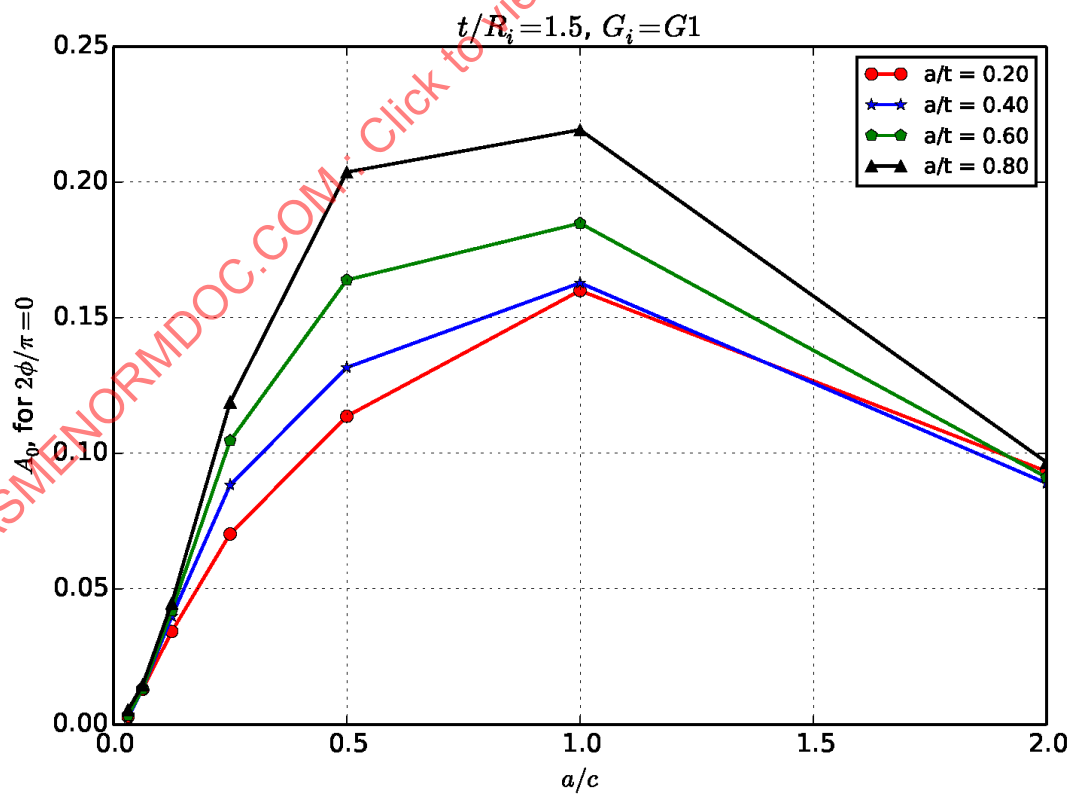
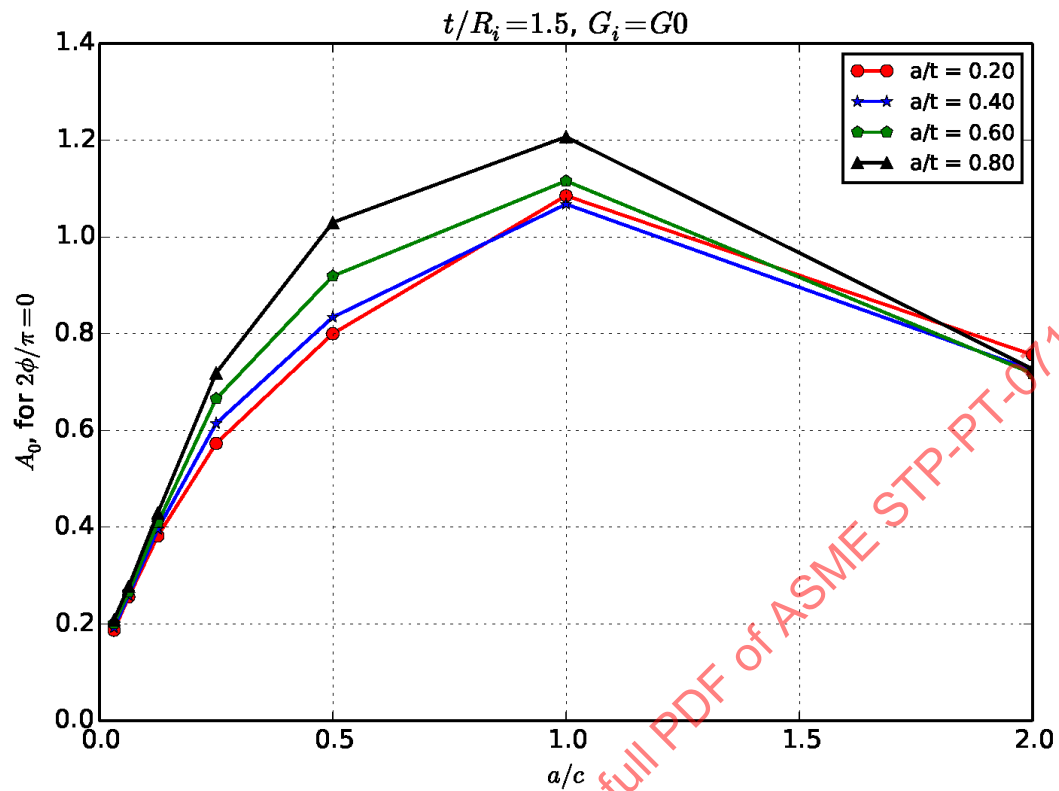


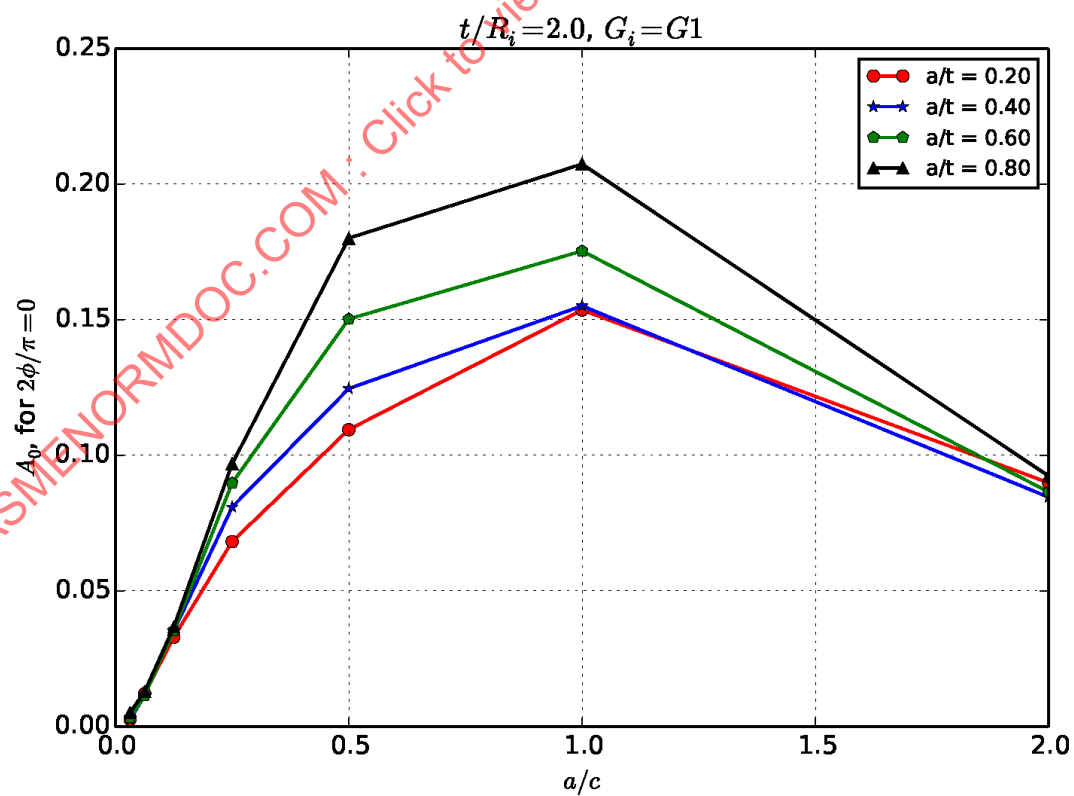
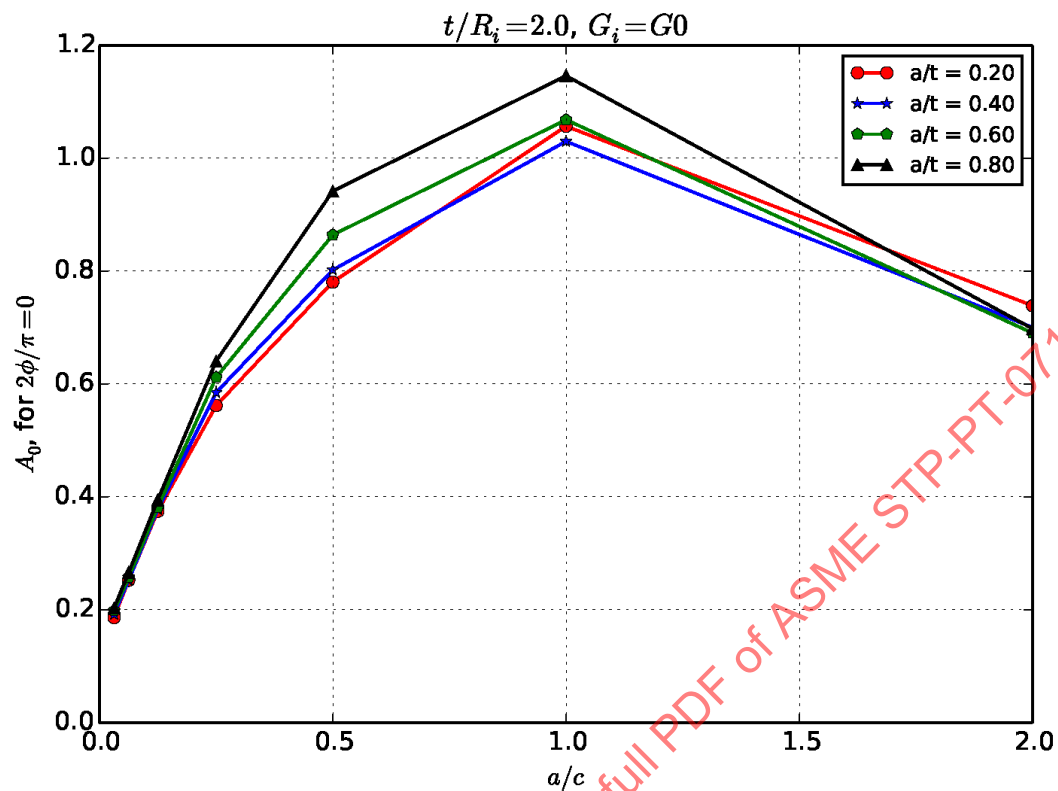
APPENDIX F - AXIAL INTERNAL SURFACE CRACK TREND PLOTS

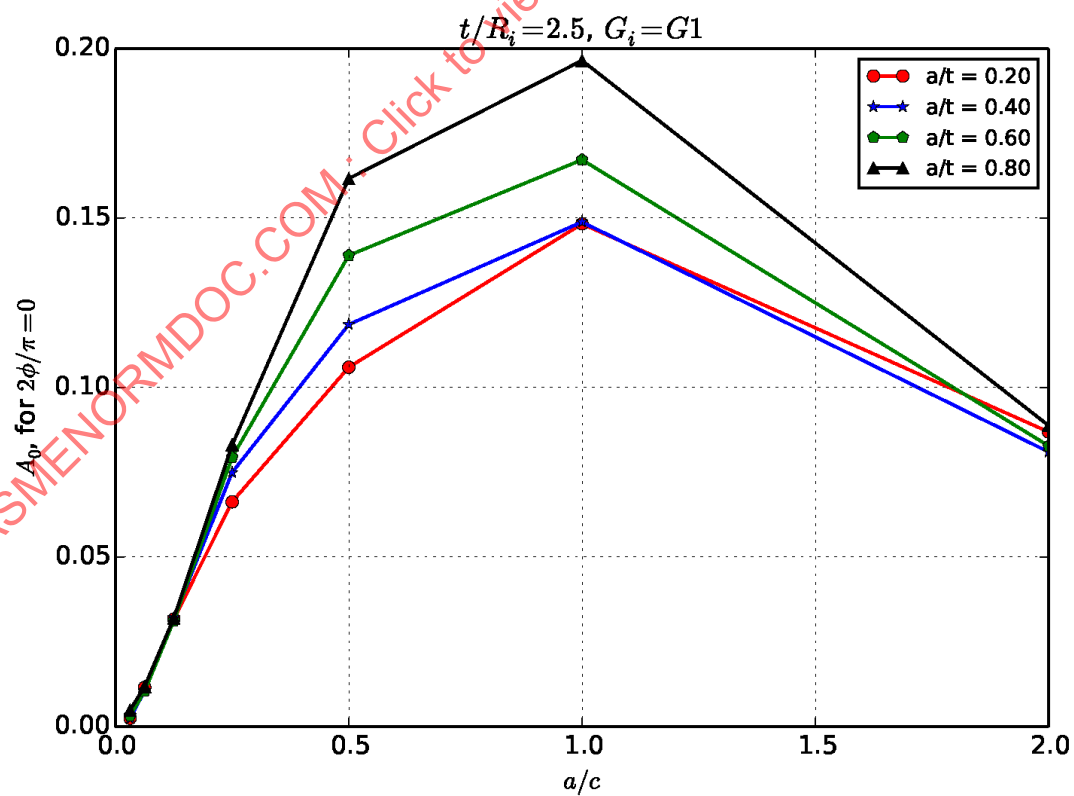
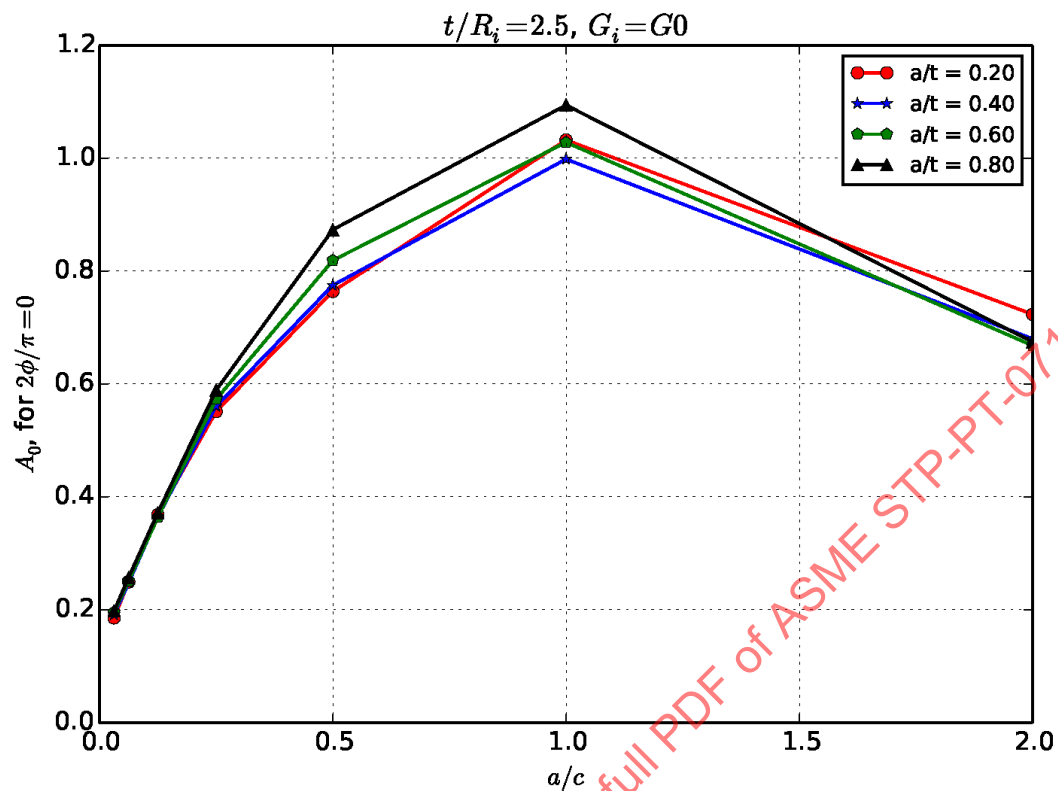
Plots to compare G result trends at the crack tip (at $2\phi/\pi=0$) and at the crack depth (at $2\phi/\pi=1$) for the axial internal surface cracks. Four curves per plot for each a/t ratio; 20 plots total. At the crack tip, plot the $G = A_0$ curve-fit coefficient versus the a/c ratio; see the first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

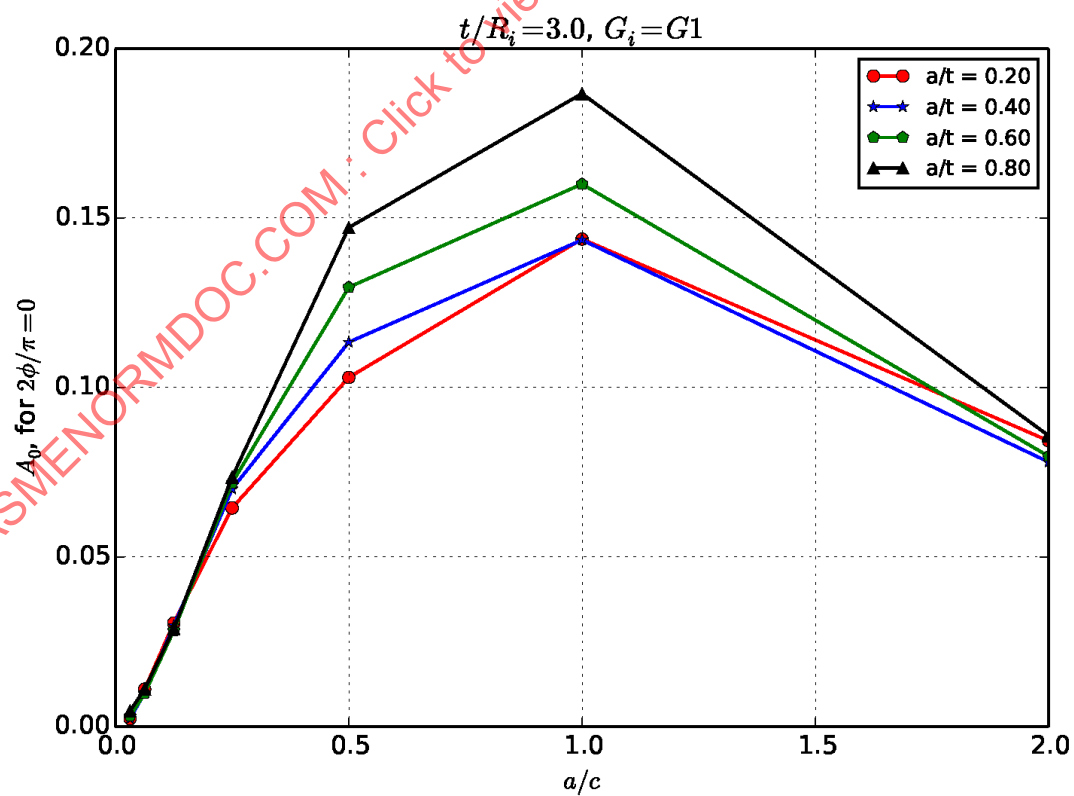
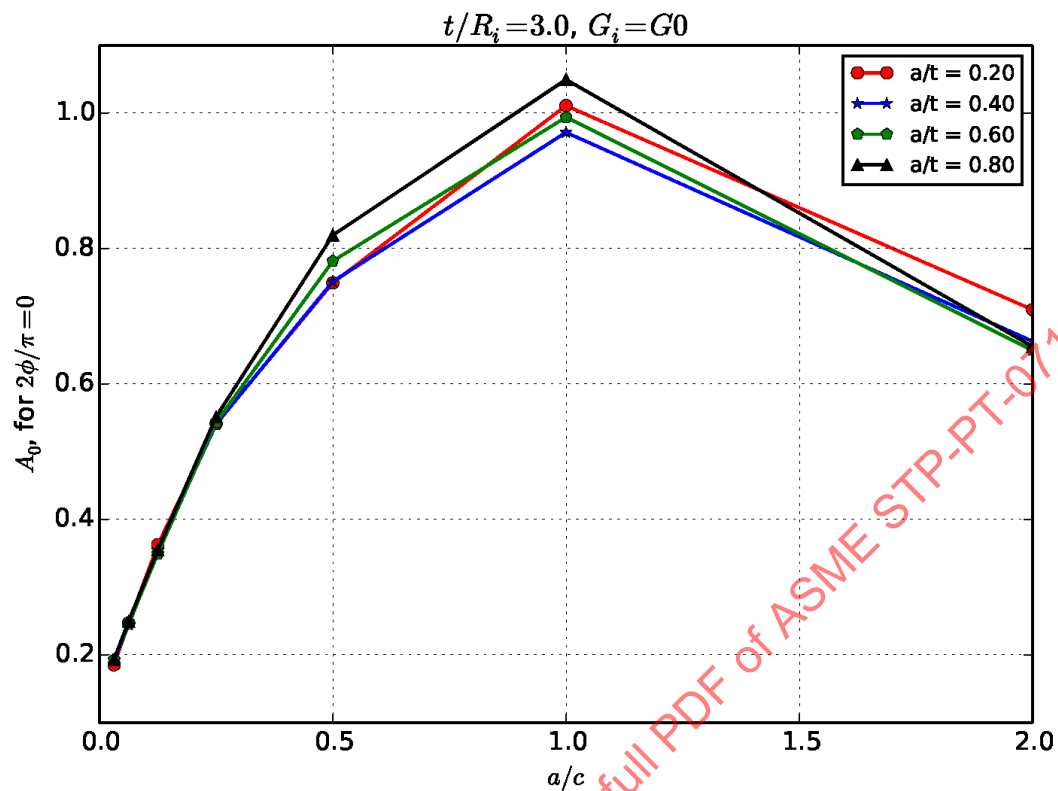
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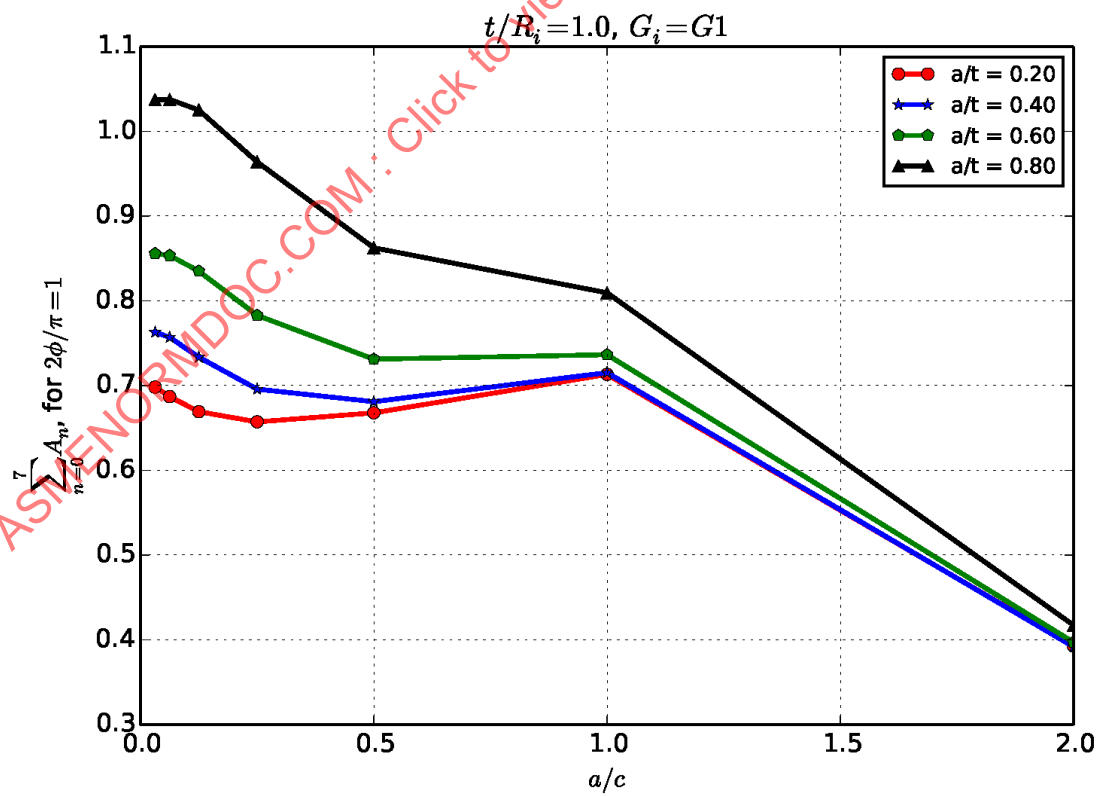
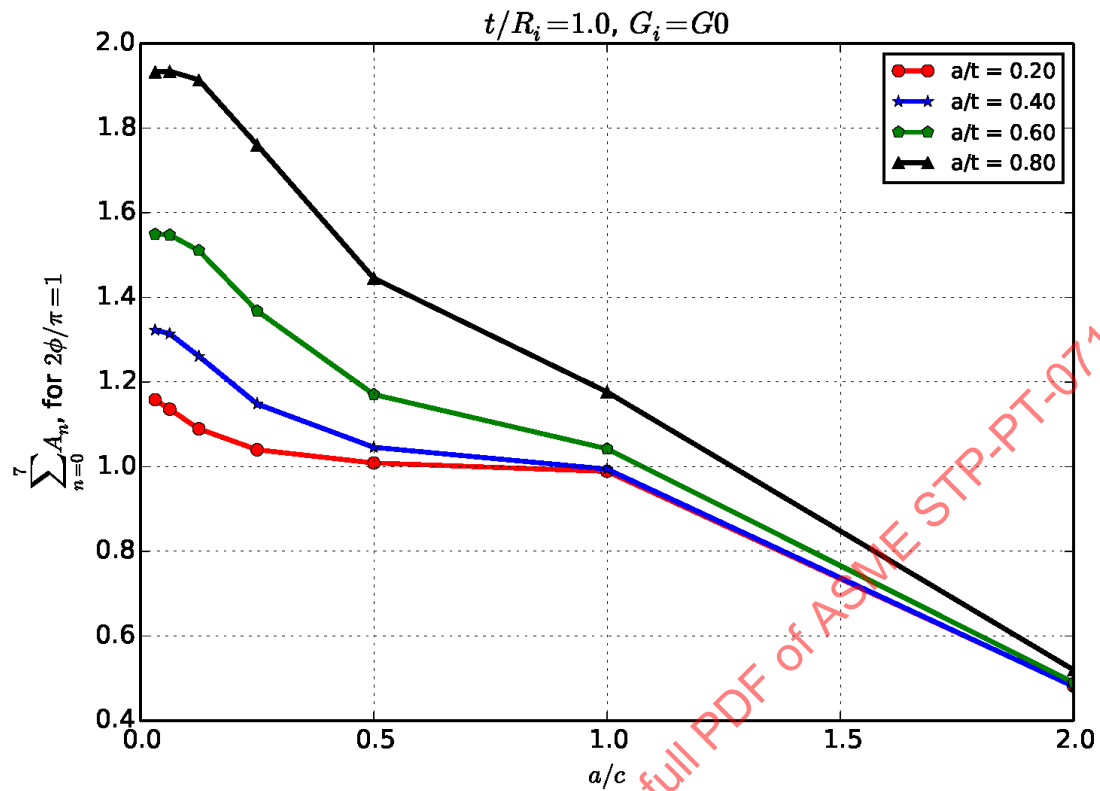


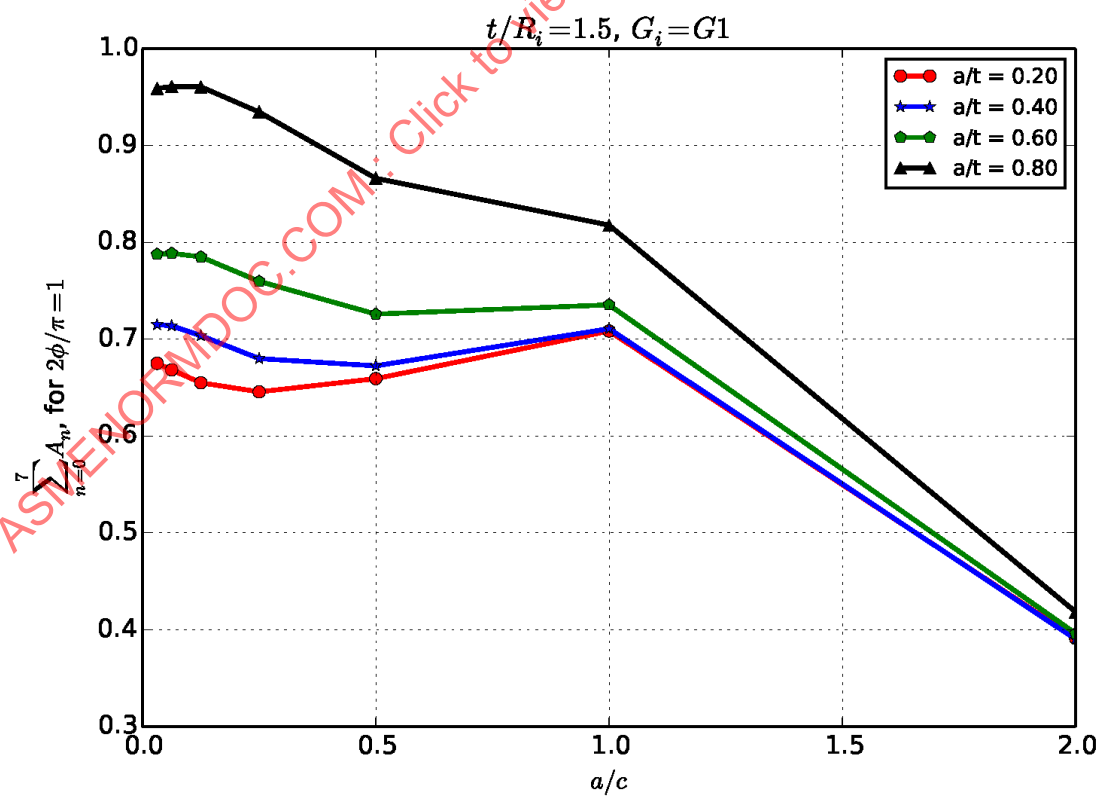
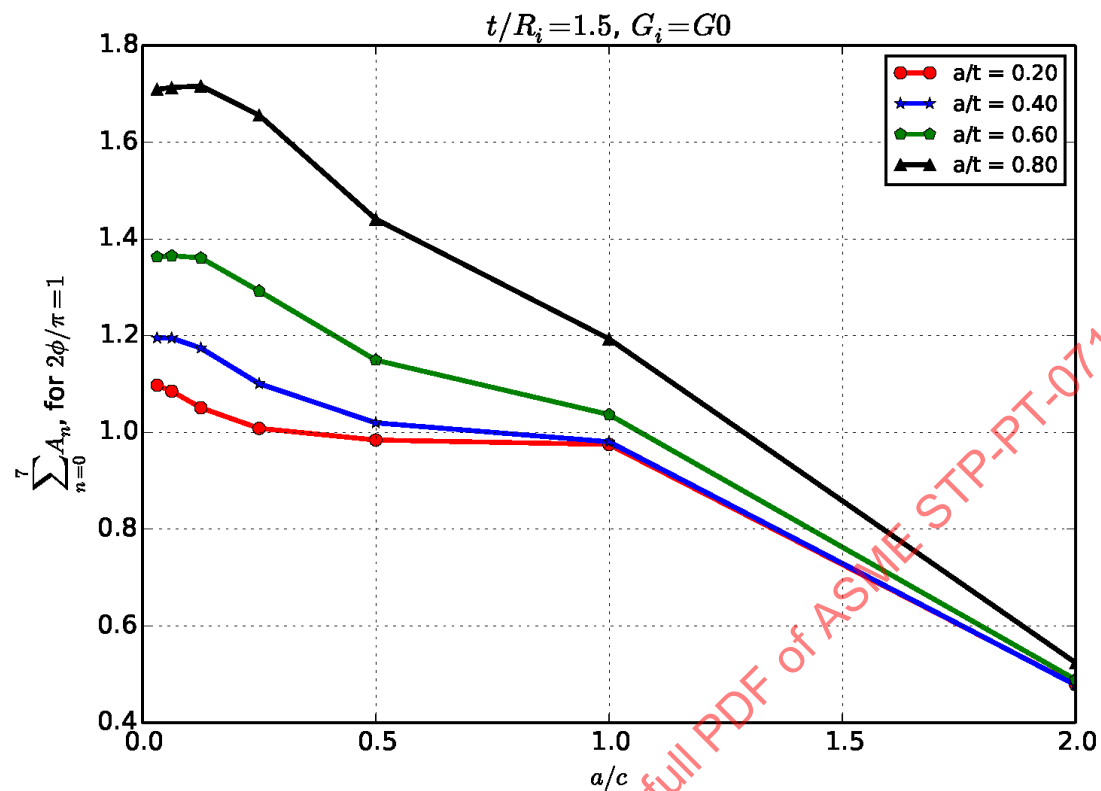


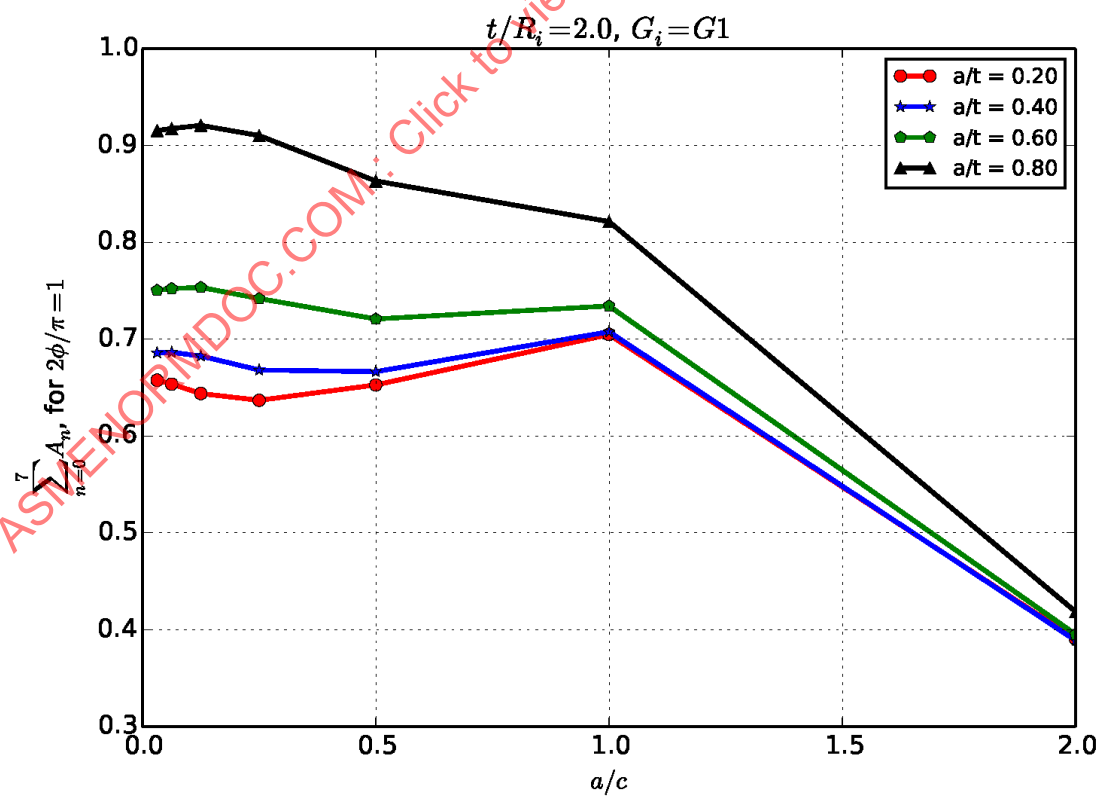
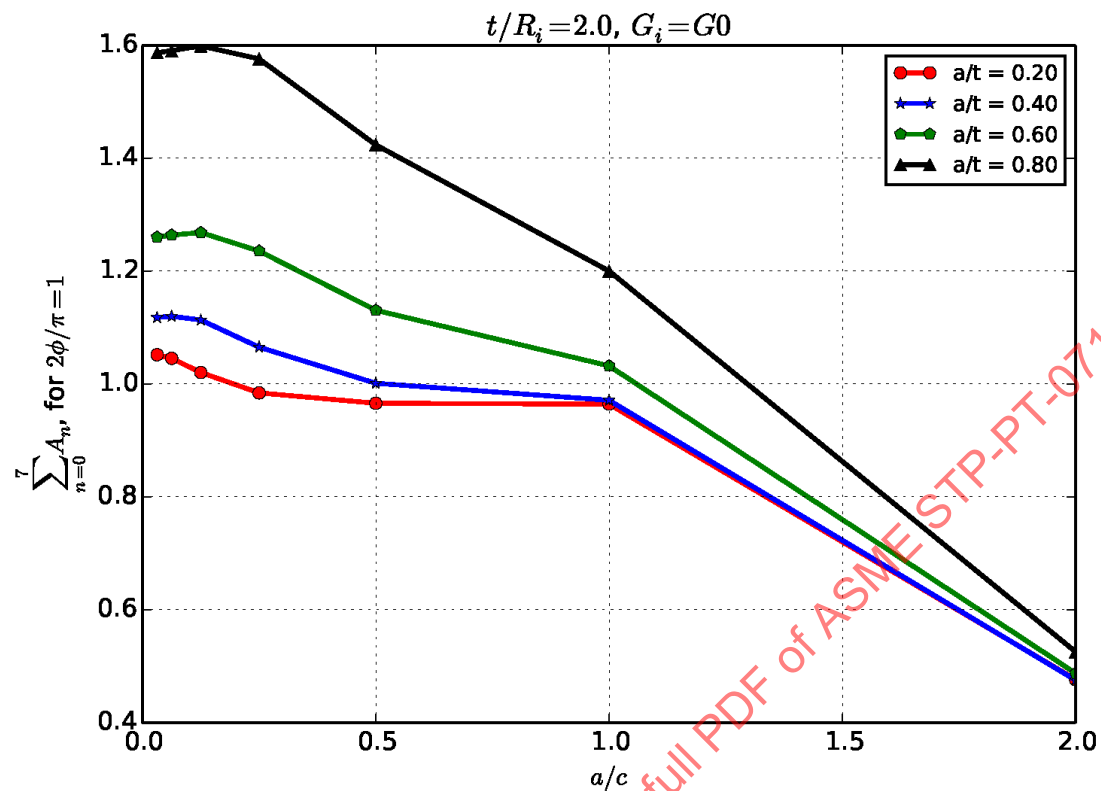


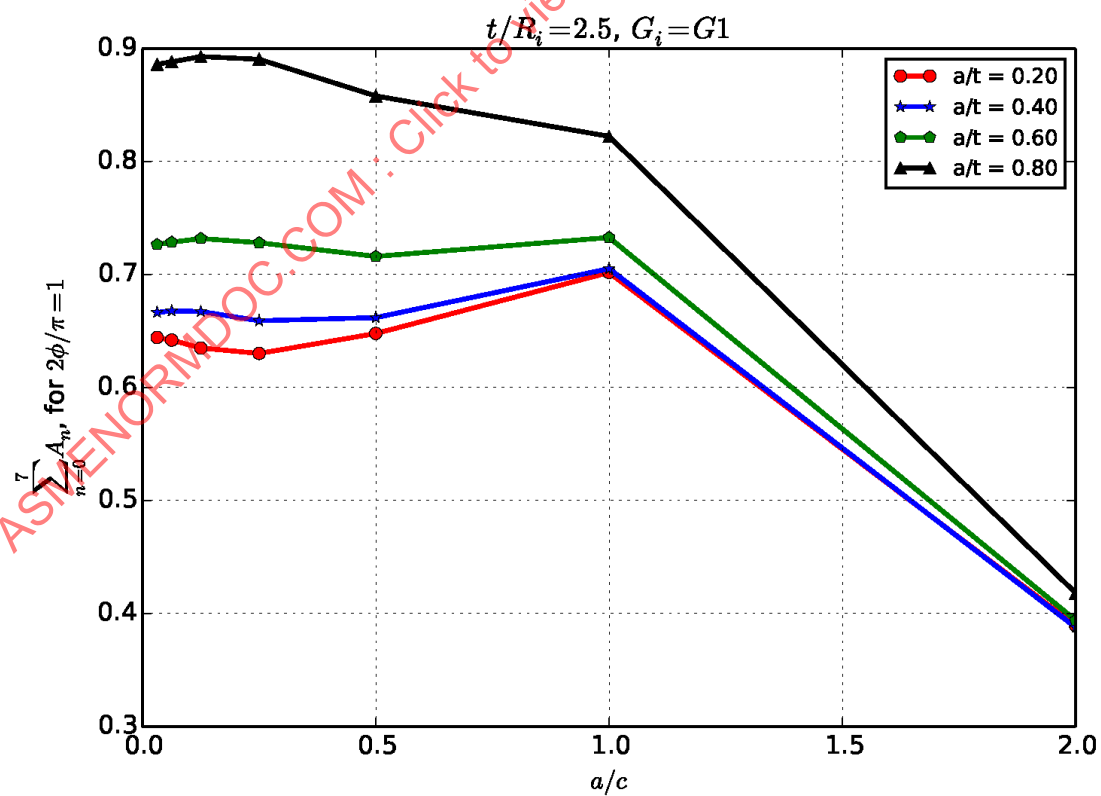
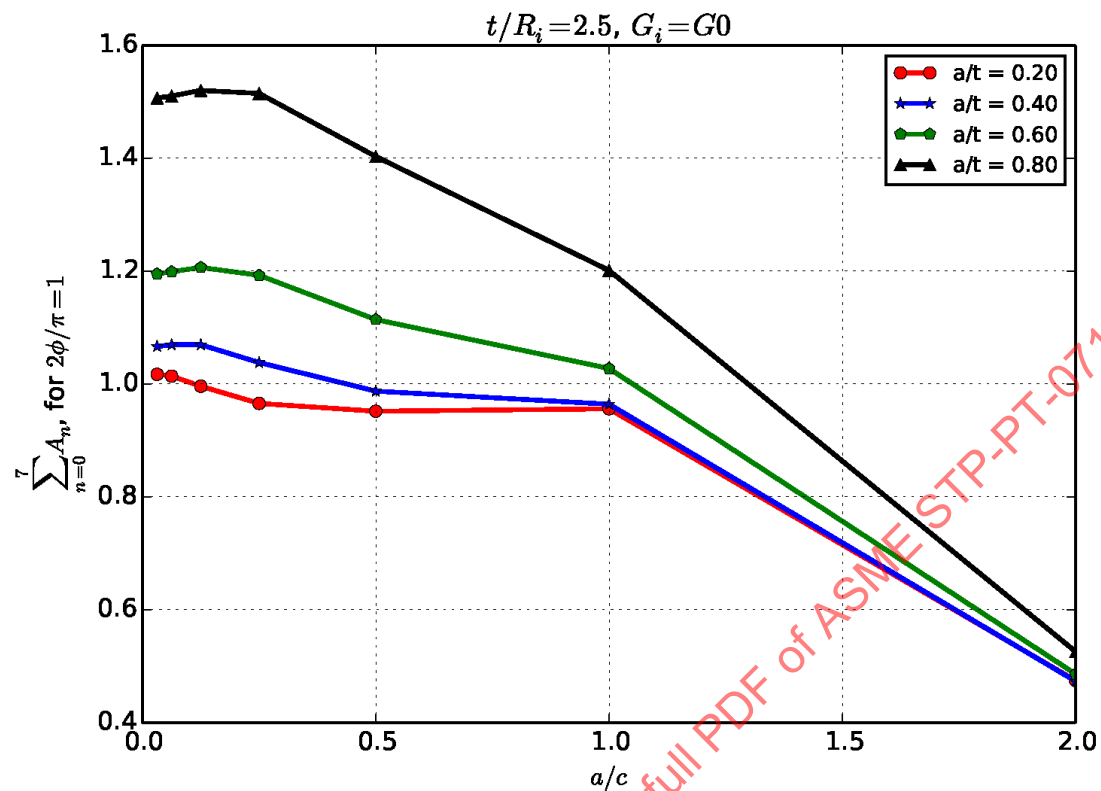


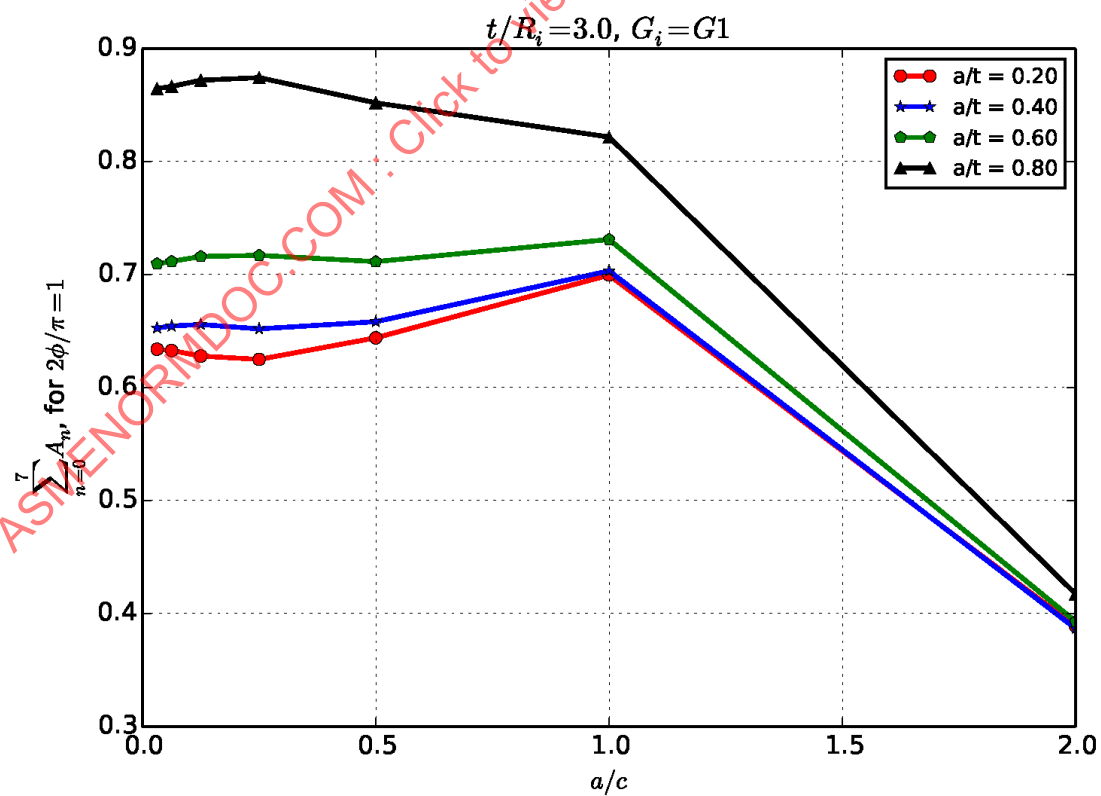
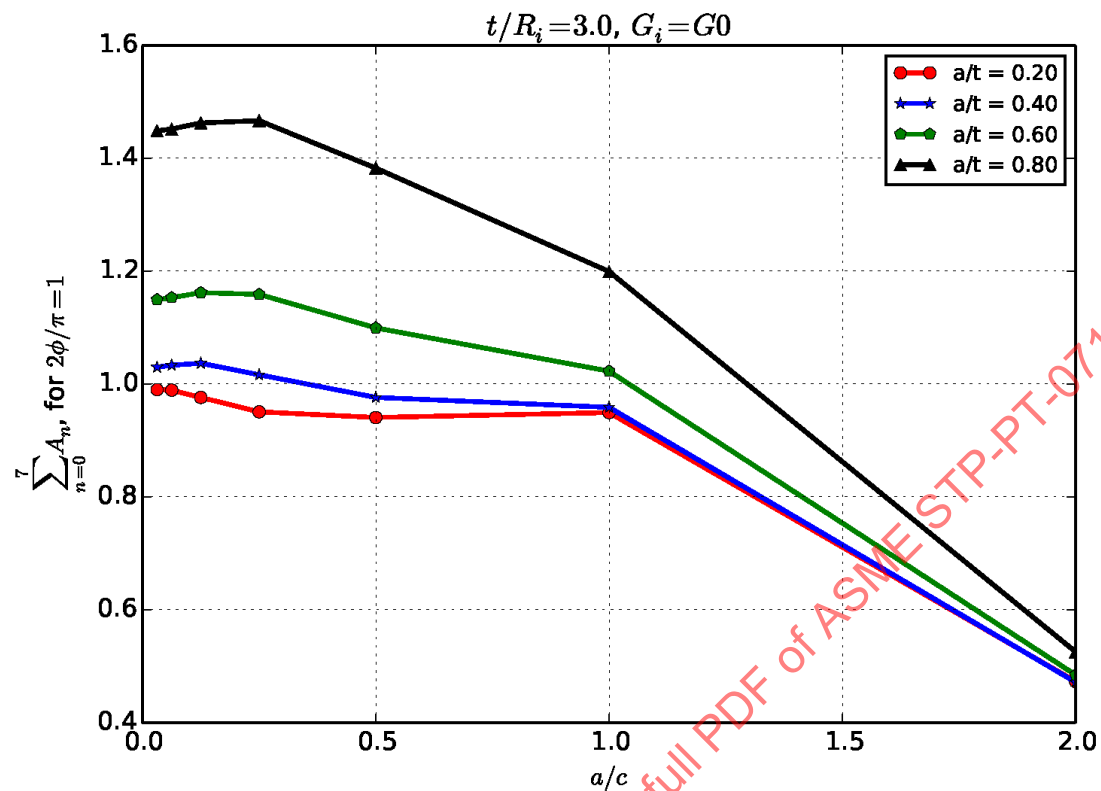








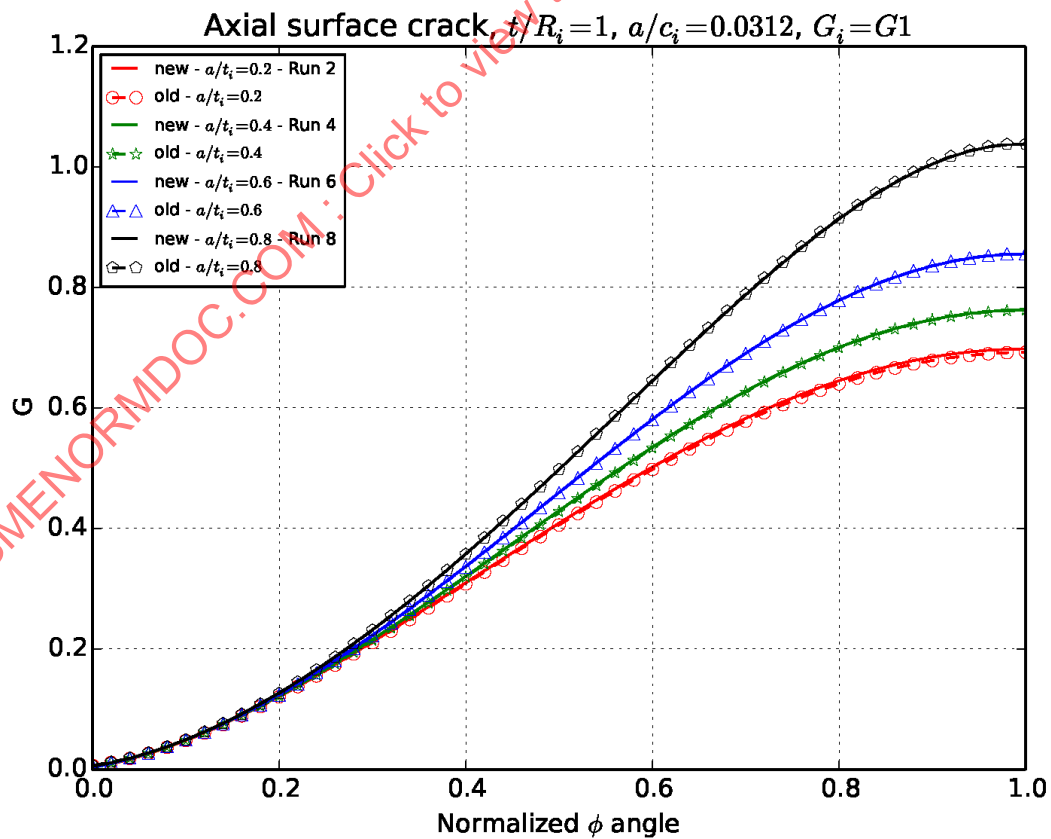
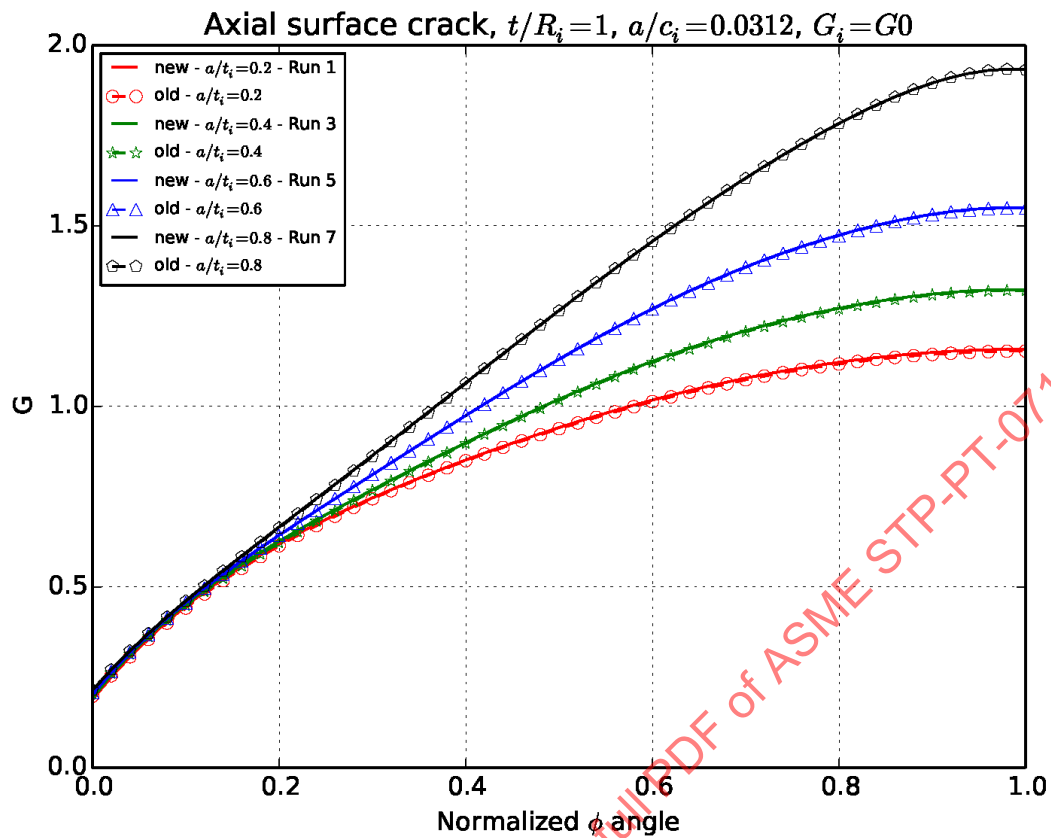


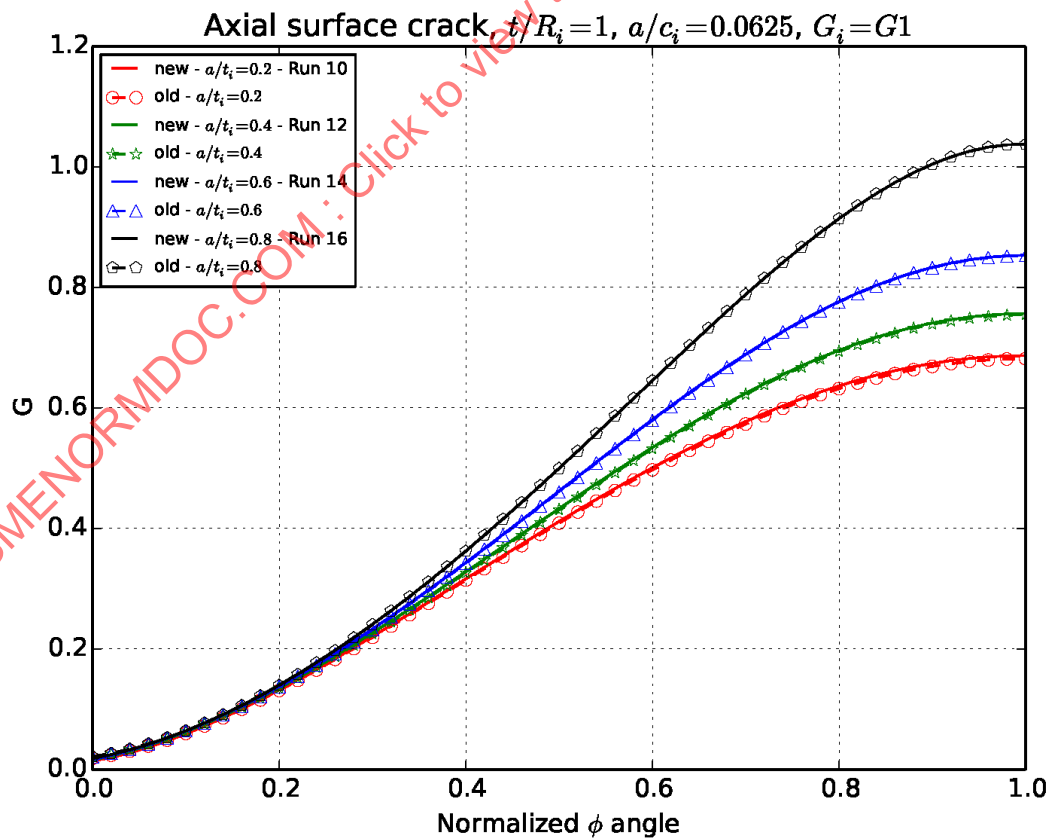
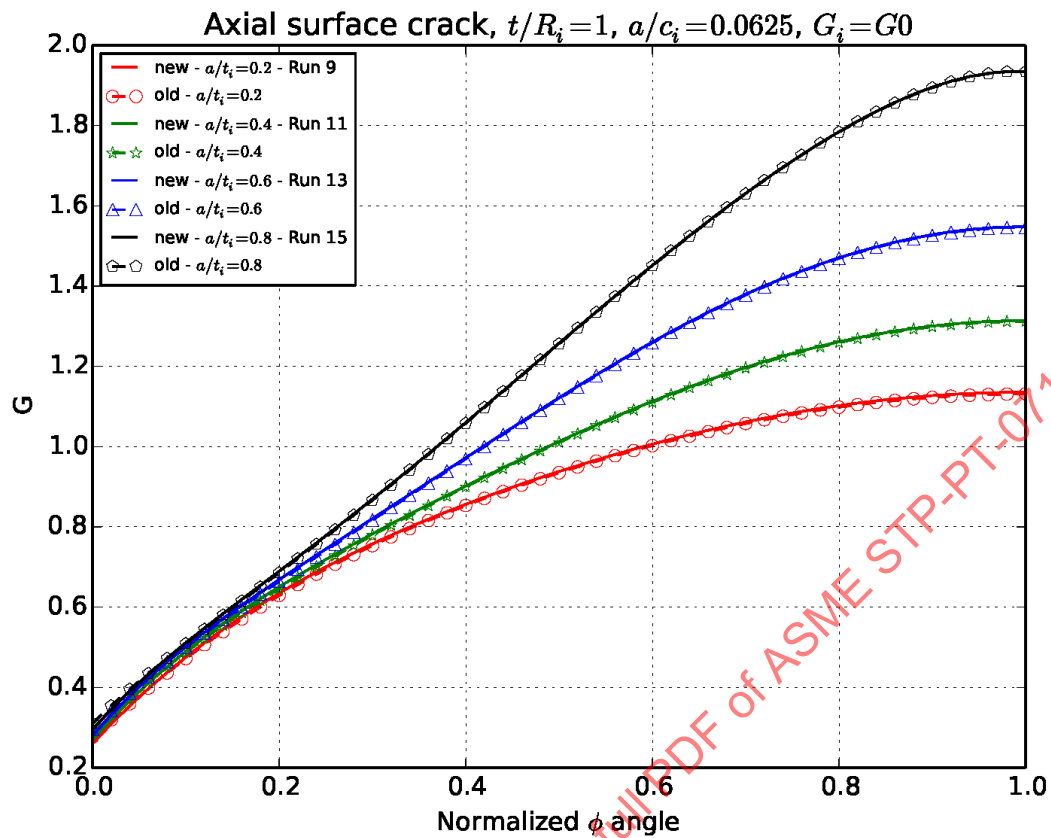


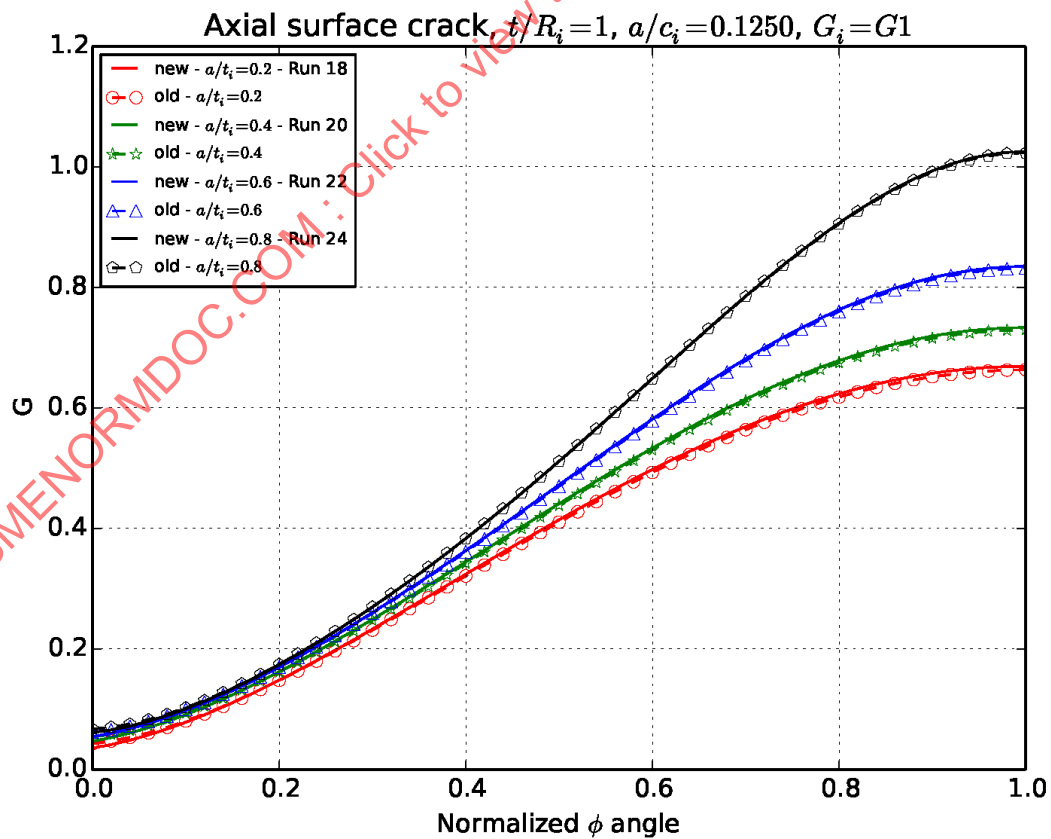
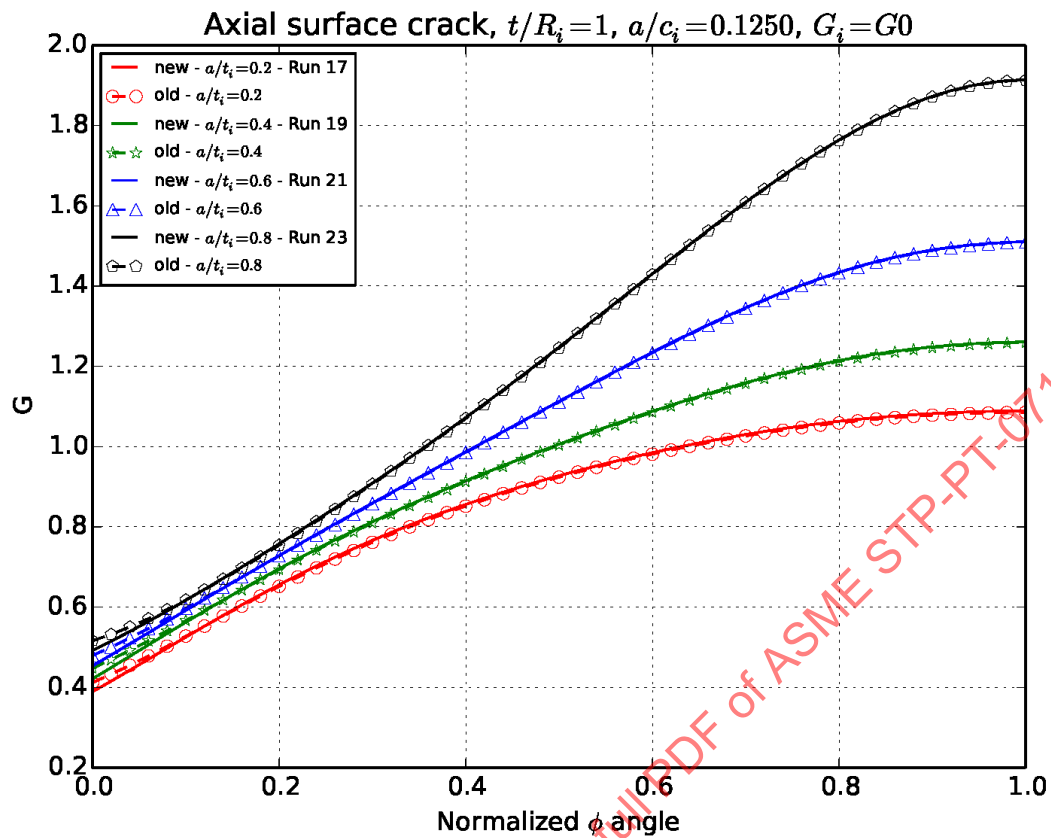
APPENDIX G - AXIAL INTERNAL SURFACE CRACK COMPARISON TO PREVIOUS RESULTS

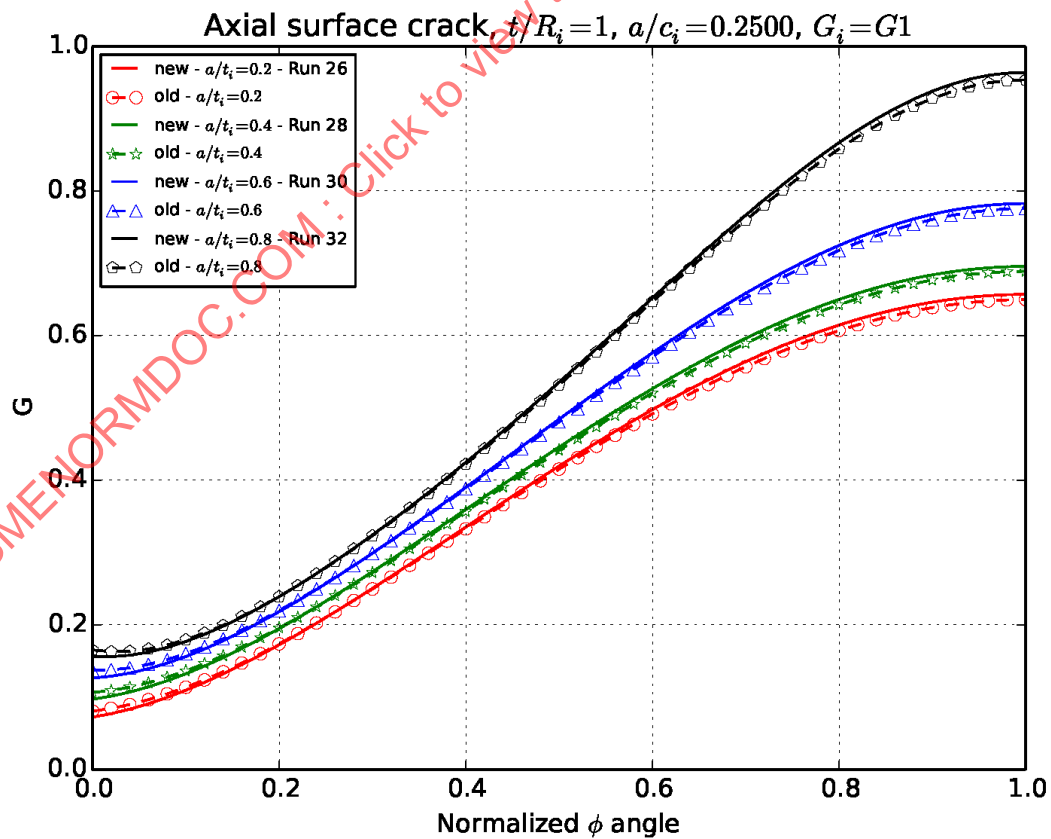
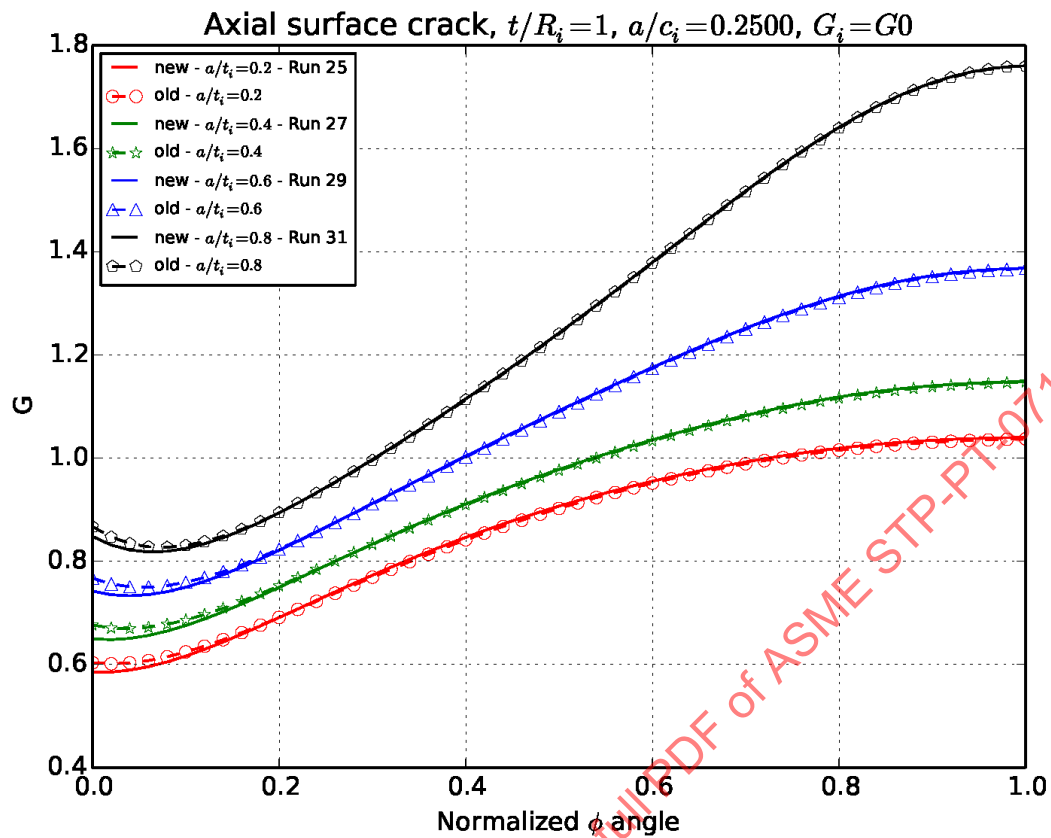
Plots to compare G results for the $t/R_i=1$ ratio from the previous results to the new results for the axial internal surface cracks. The previous results were obtained from API 579, Annex C, Table C.12 [1]. Plot curves with data points and dashed lines show the previous results, and plot curves with solid lines show the new results; 14 plots total. Generally good agreement, except for the $a/c=1, 2$ cases (semi-circular and shorter crack); the new results are an improvement with more mesh refinement.

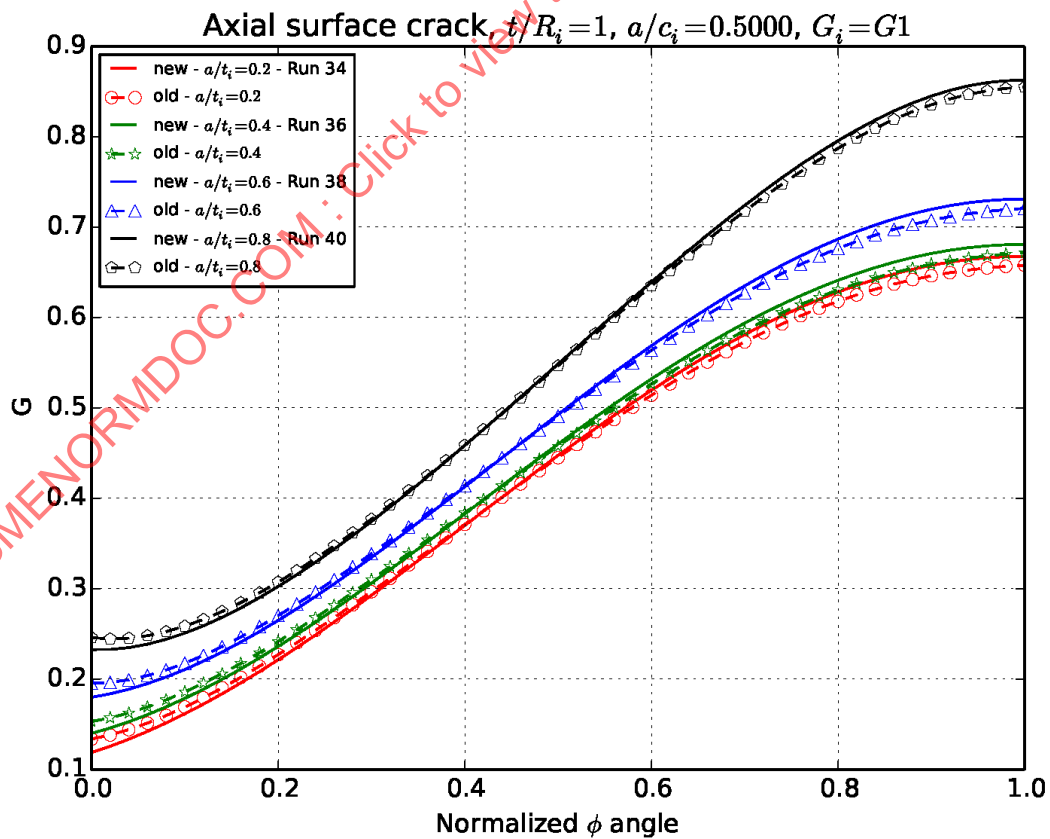
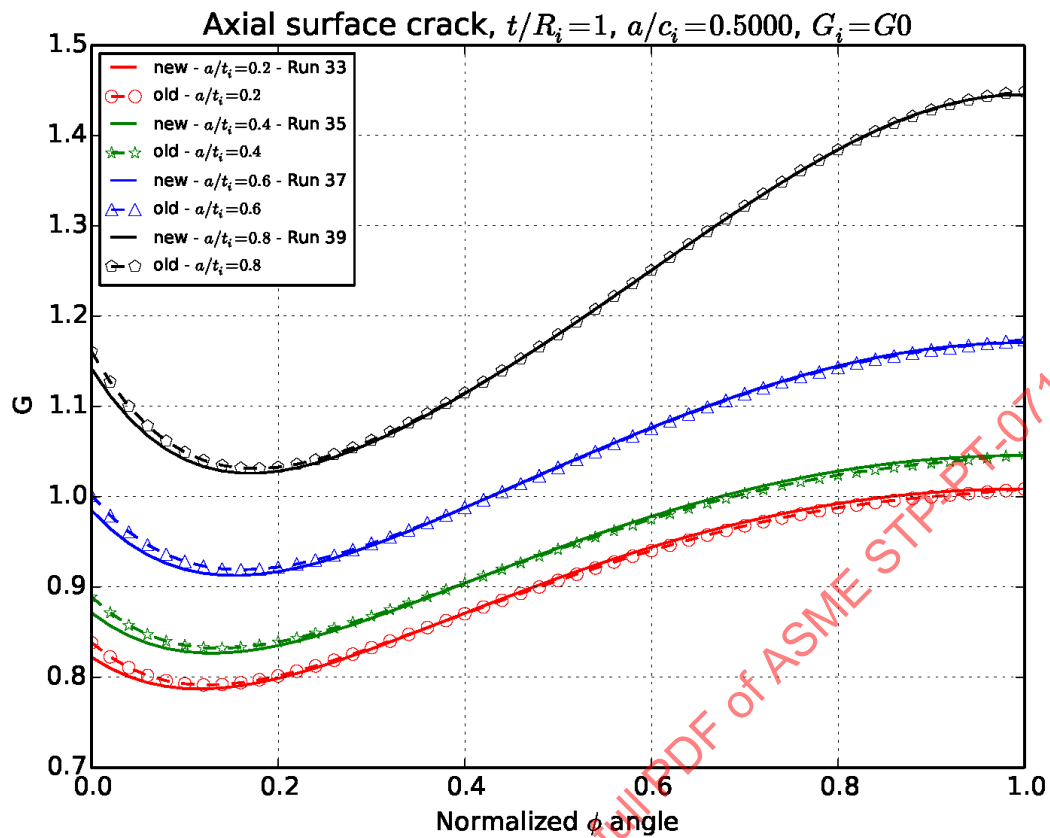
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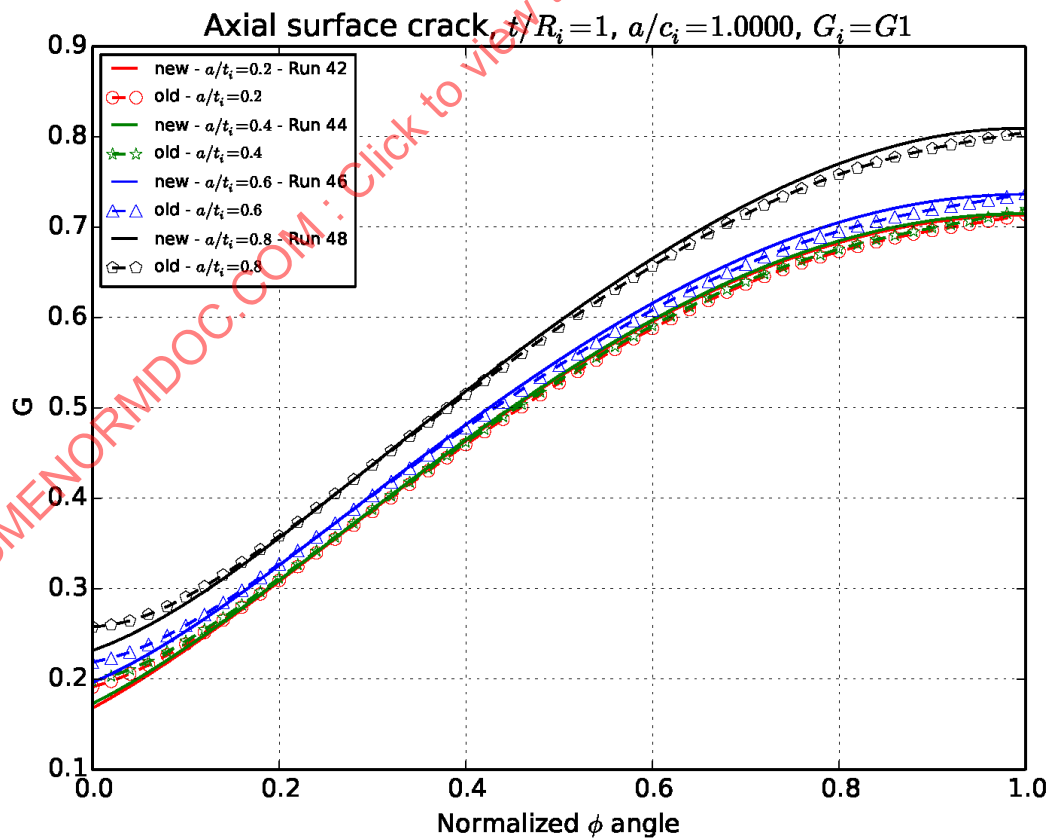
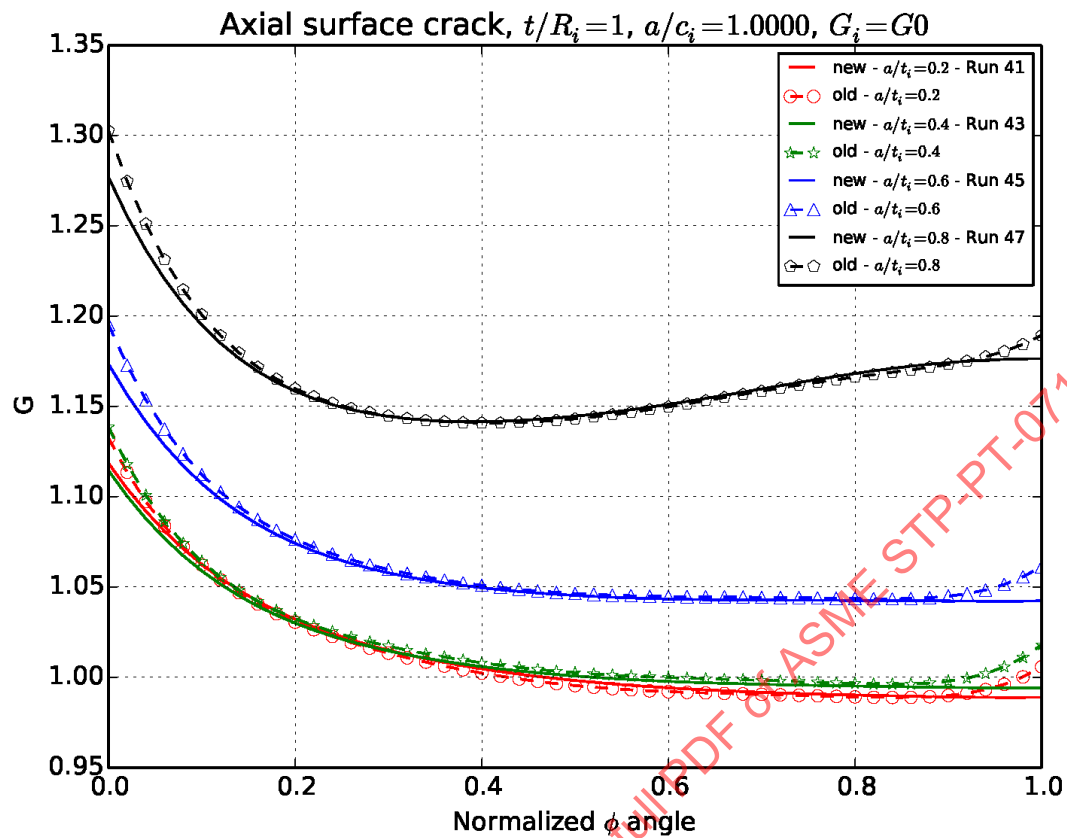


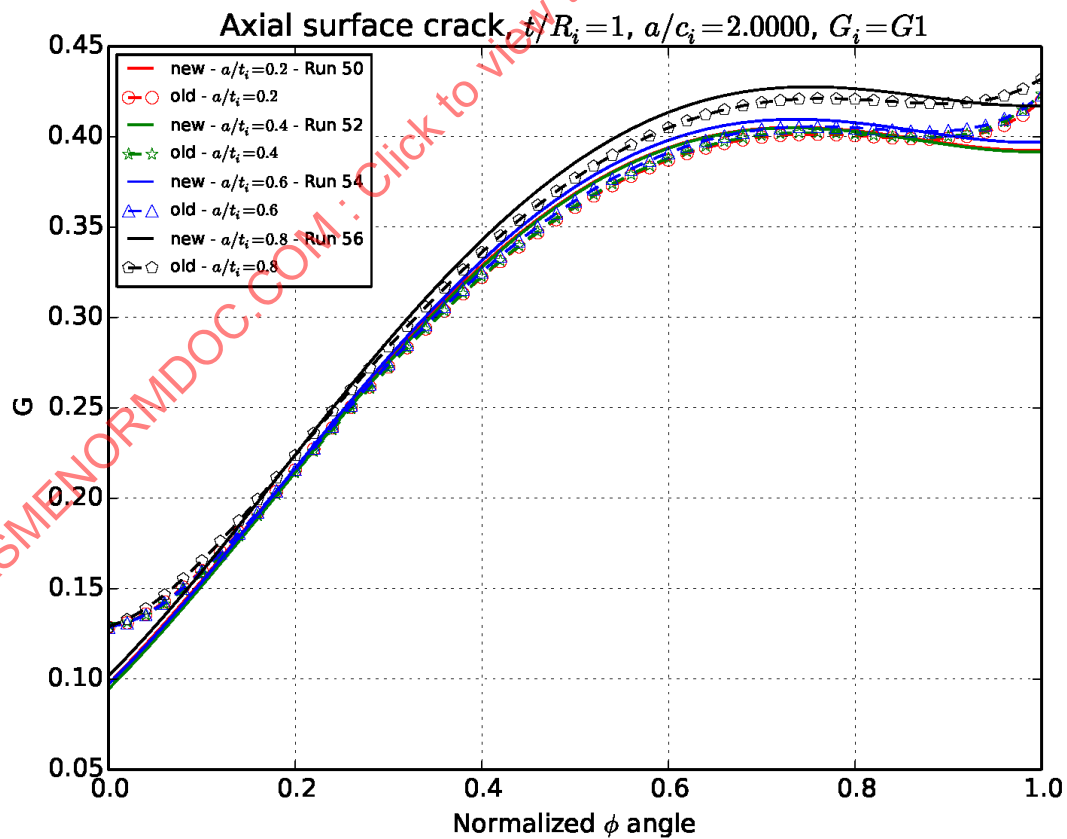
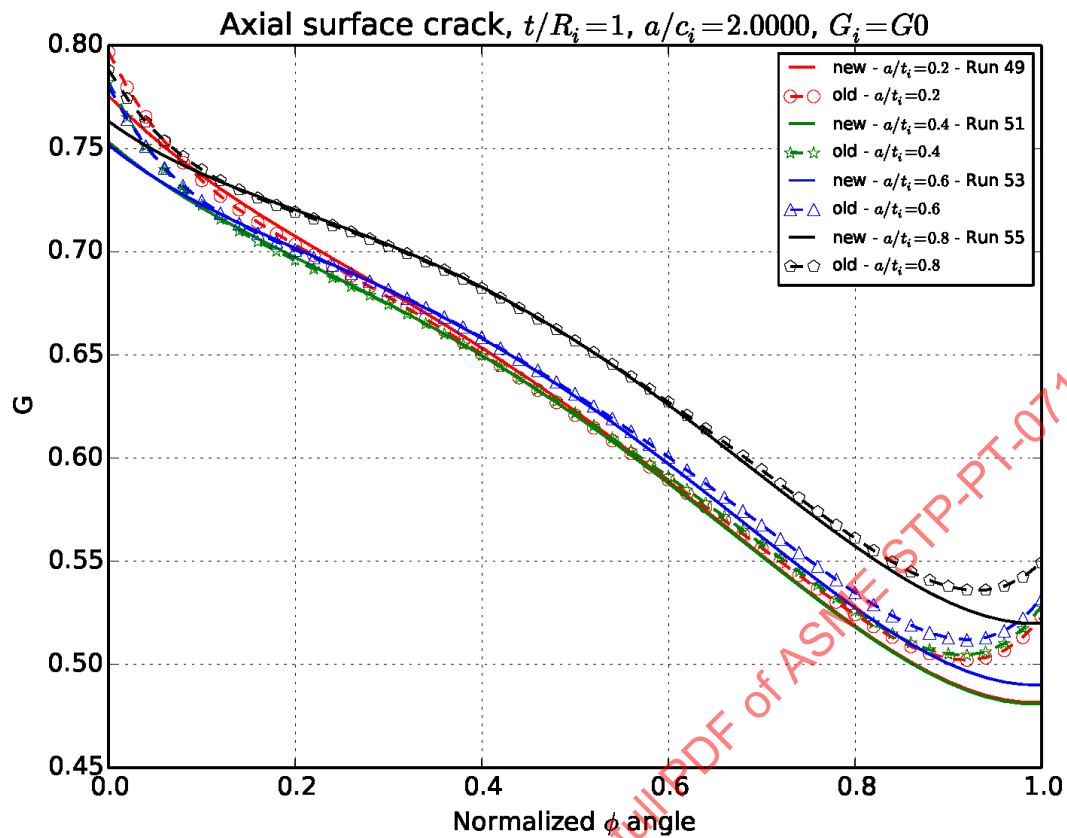








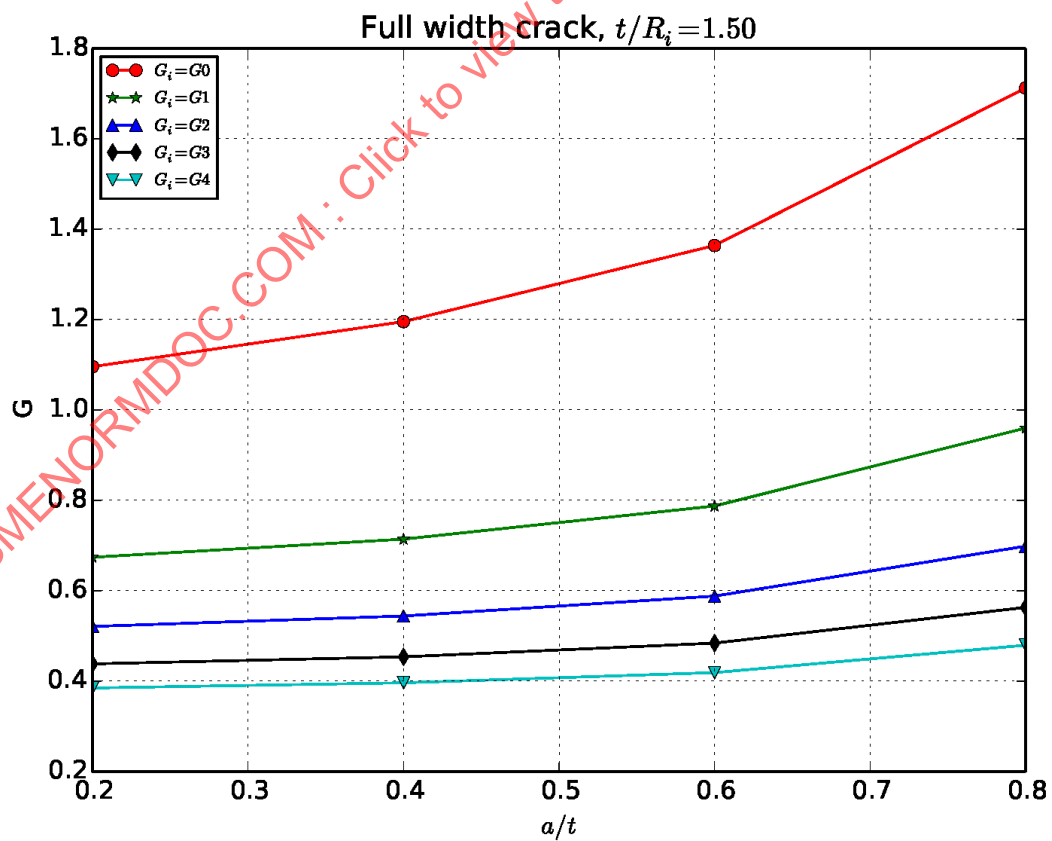
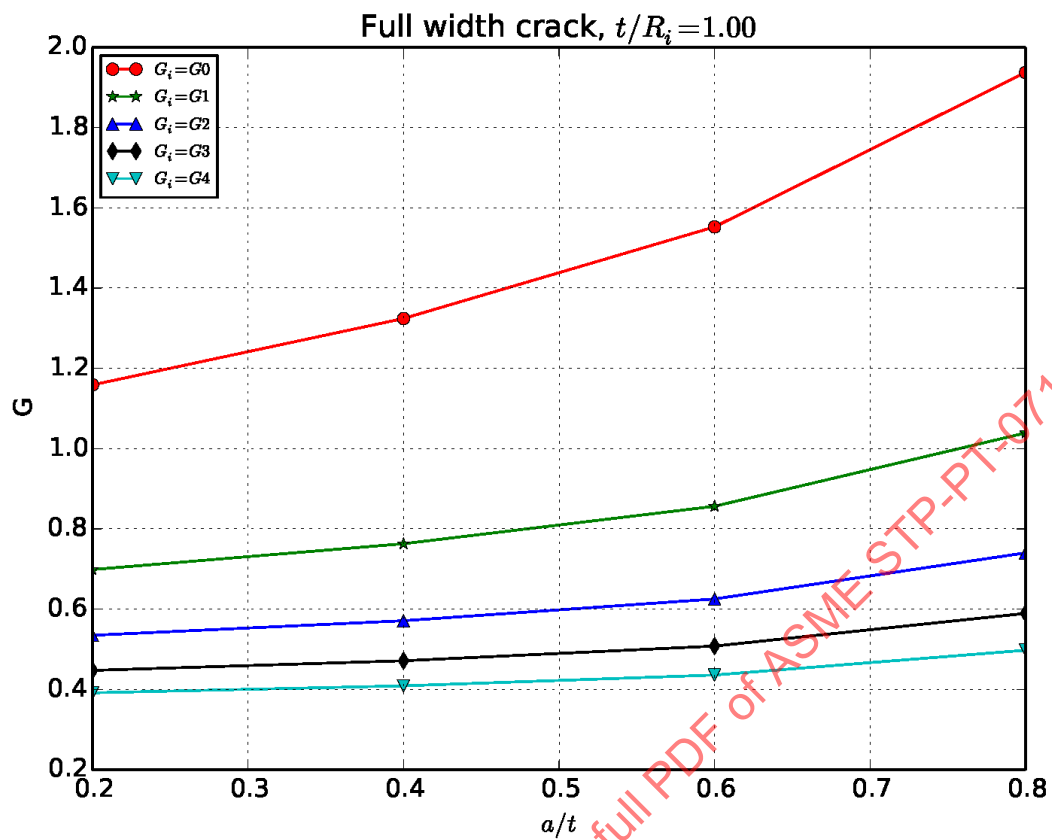


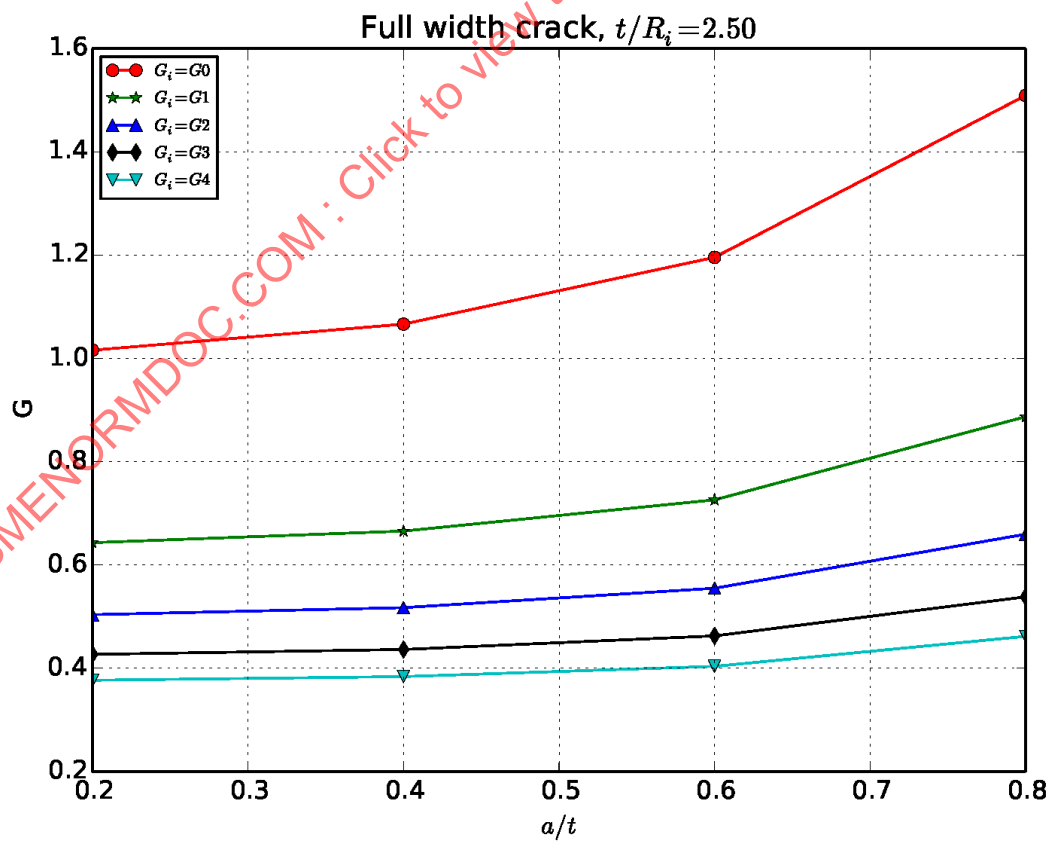
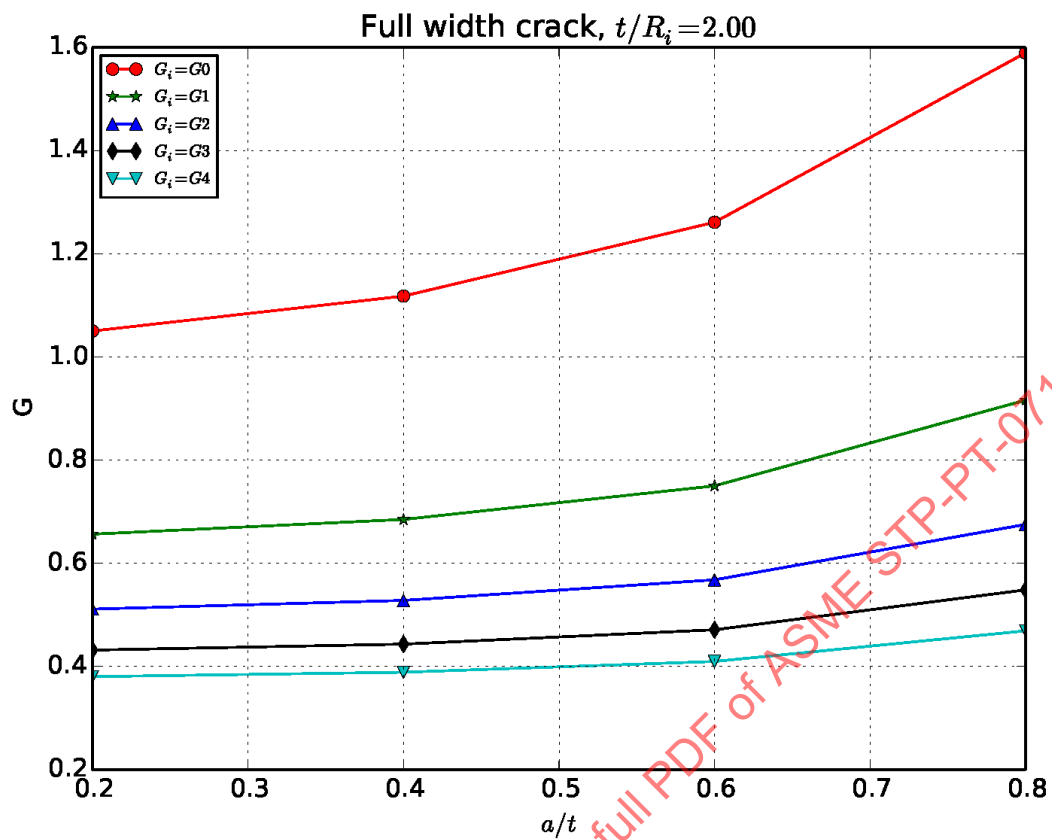


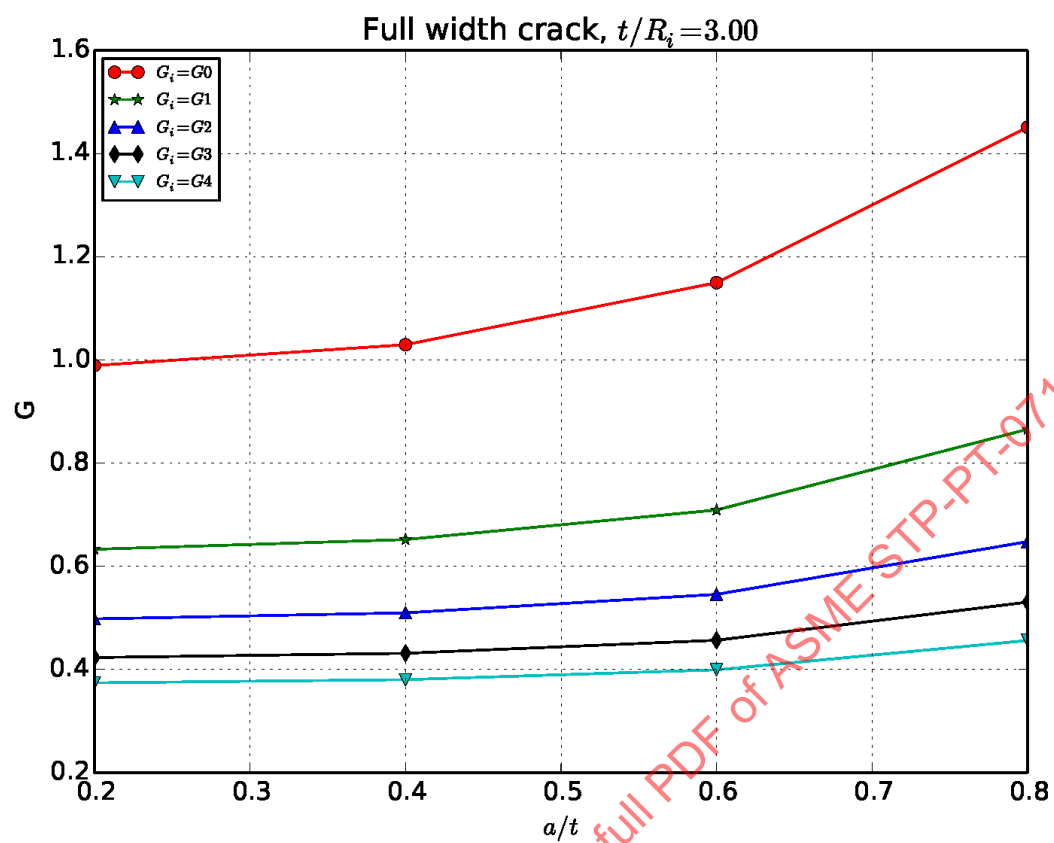
APPENDIX H - AXIAL INTERNAL FULL-WIDTH CRACK G RESULT PLOTS

Plots shown for all the axial internal 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: G_0 to G_4 for uniform, linear, quadratic, cubic, and quartic crack face pressure distributions. Five plots total for each t/R_i ratio.

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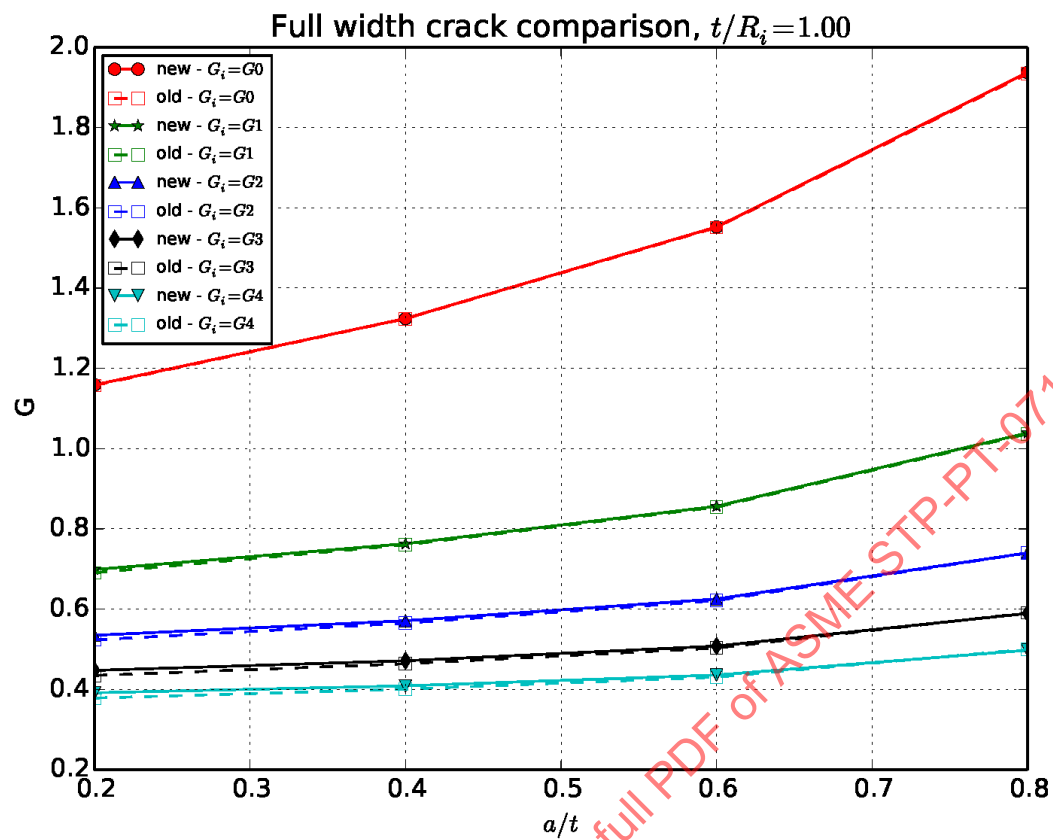




APPENDIX I - AXIAL INTERNAL FULL-WIDTH CRACK COMPARISON TO PREVIOUS RESULTS

Plots to compare axial full-width crack G results for the $t/R_i=1$ 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].

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APPENDIX J - CIRCUMFERENTIAL INTERNAL SURFACE CRACK G RESULT 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; 44 plots total. Each page contains the plots for a particular t/R_i and a/c ratio. The G_0 and G_1 results are in the first 22 plots, and the G_5 and G_6 results are in the last 22 plots.

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