Mesh Check

Mesh: All_Hex_Dec.inp

Abaqus

Abaqus doesn't provide Jacobian directly, they mesh verification results showing:

Part instance: PART-1-1

Number of elements : 1171570, Analysis errors: 0 (0%), Analysis warnings: 7847 (0.669785%)

Cubit

Cubit verifies 173 elements with negative Jacobian, consistent to Chad's report.

Cubit>quality hex all jacobian global high 0 draw mesh

ERROR: Malformed element.

Hex quality, 173 elements:

Function Name Average Std Dev Minimum (id) Maximum (id)

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Jacobian -1.265e-10 1.499e-10 -9.606e-10 (471580) -2.240e-13 (868418)

Finished Command: quality hex all jacobian global high 0 draw mesh

Cubit>quality hex all scaled jacobian global high 0 draw mesh

ERROR: Malformed element.

Hex quality, 173 elements:

Function Name Average Std Dev Minimum (id) Maximum (id)

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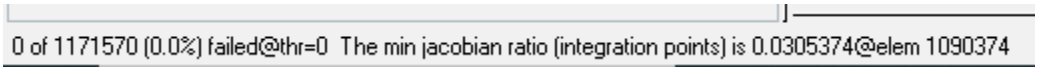
Scaled Jacobian -1.684e-01 1.554e-01 -6.802e-01 (1090373) -3.747e-03 (904387)

Finished Command: quality hex all scaled jacobian global high 0 draw mesh

Hypermesh

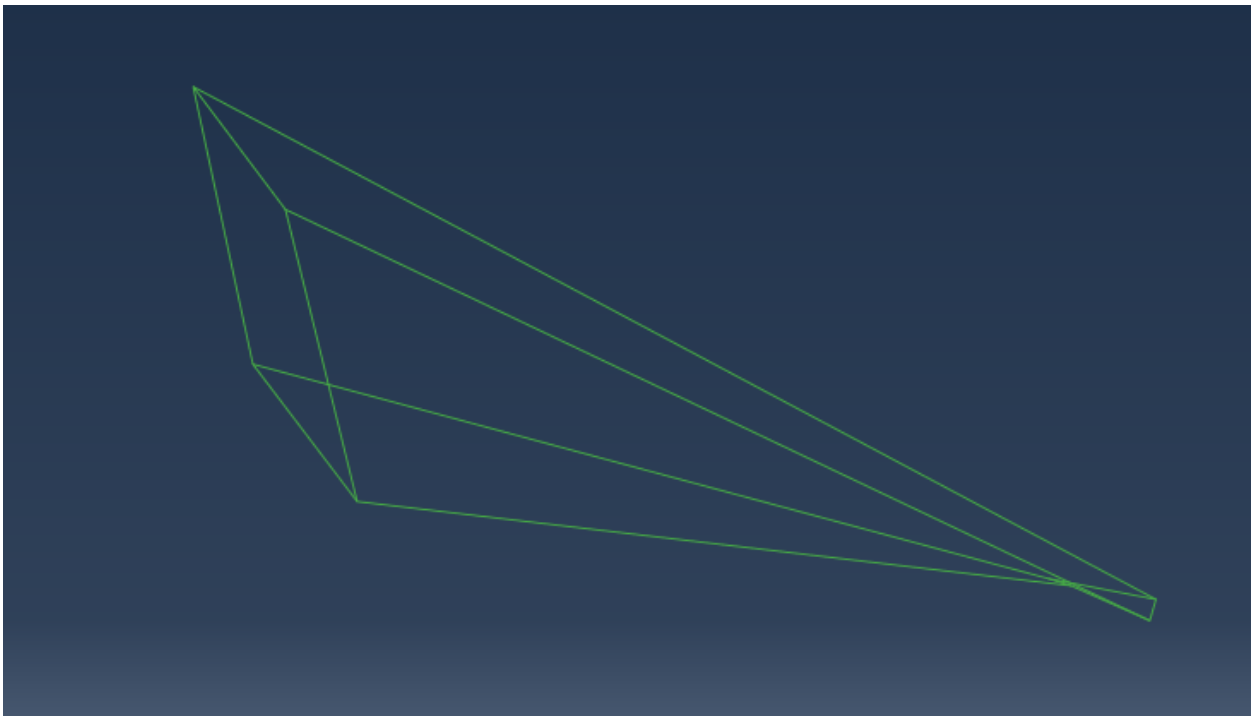
Hypermesh showing no elements with negative Jacobian.



Locate an element with negative Jacobian in Abaqus, Cubit, and Hypermesh:

Element ID: 772179

Abaqus:



Part instance: PART-1-1, Element: 772179, Shape: hex

Min/Max angle: 26.31 / 155.10, Aspect ratio: 9.09

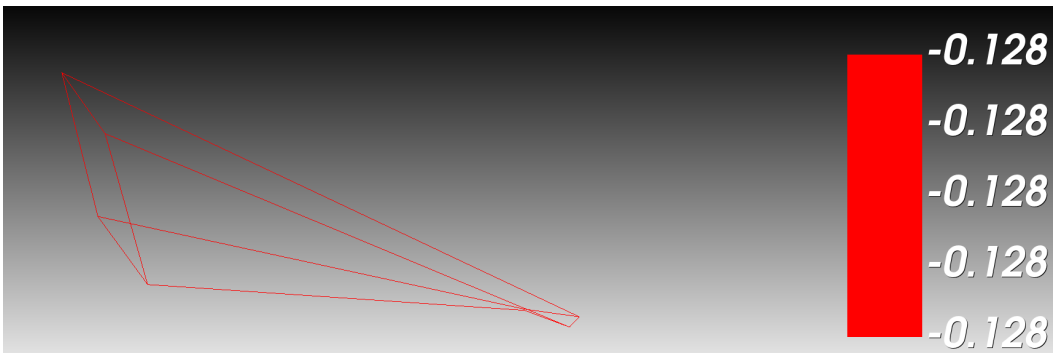
Geometric deviation factor: NA

Stable time increment: 1.38e-07, Max frequency: NA

Shortest/Longest edge: 2.36e-04 / 0.00215, Analysis checks: Warning

*Analysis checks: Warning (warning for distorted elements) are not necessary for all elements determined having negative jacobian by cubit

Cubit:



*In above figure, -0.128 is scaled Jacobian, the Jacobian is -0.1 as:

Cubit>quality hex 772179 jacobian global high -0.1 draw mesh

ERROR: Malformed element.

Finished Command: quality hex 772179 jacobian global high -0.1 draw mesh

Geometry visibility ON.

Cubit>quality hex 772179 aspect ratio global high 100 draw mesh

Hex quality, 1 elements:

Function Name Average Std Dev Minimum (id) Maximum (id)

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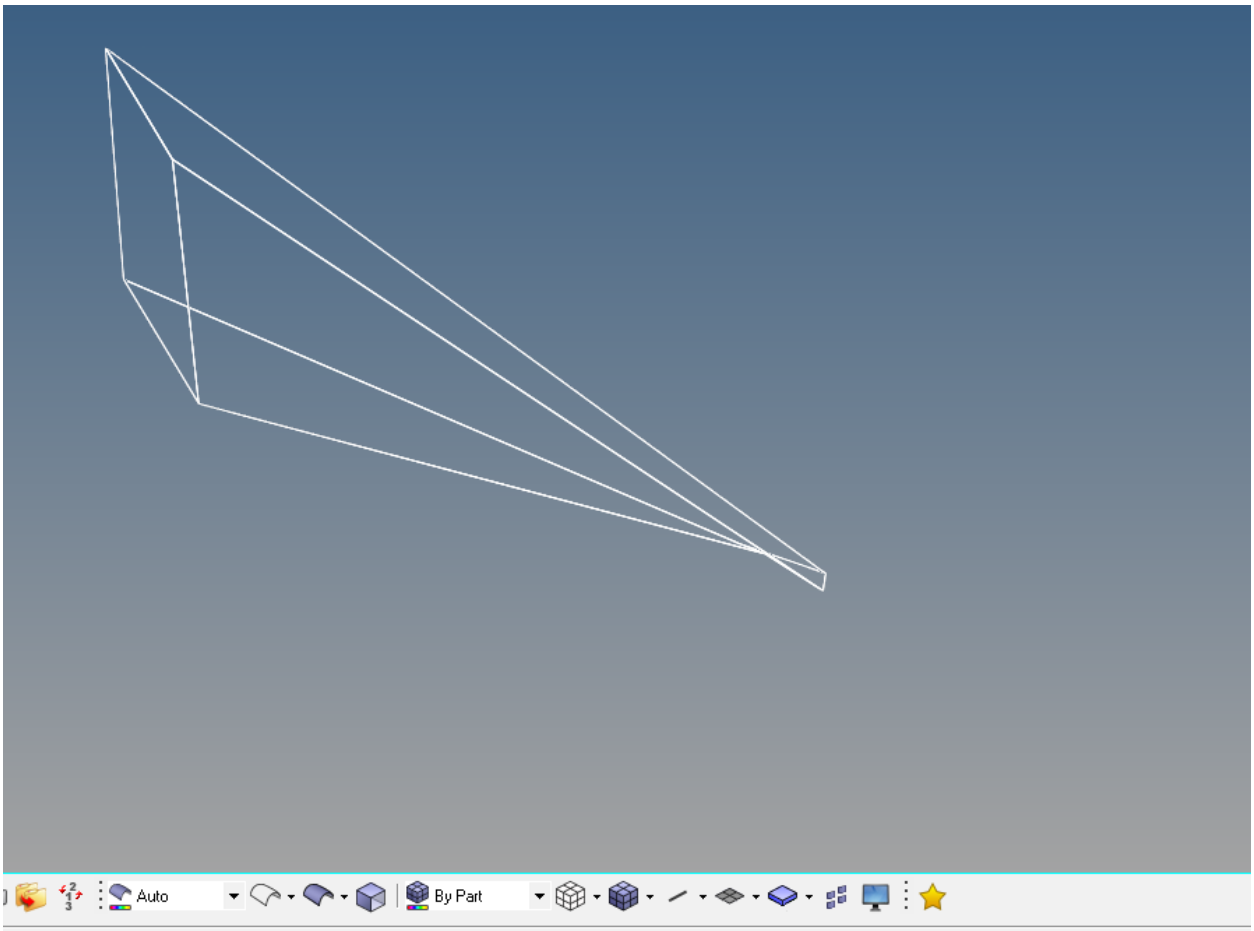
Aspect Ratio 5.038e+00 0.000e+00 5.038e+00 (772179) 5.038e+00 (772179)

Hypermesh:



element = 772179

warpage = 107.85 deg
aspect ratio = 9.085
length min/max = 1.173e-05 / 2.146e-03
angle min/max = 26.31 / 215.63 deg

skew = 0.000
jacobian = +0.2152
vol AR = 9.085
equia skew = +1.00000
cell squish = +0.95166

Abaqus doesn’t provide jacobian, but the aspect ratio agrees with Hypermesh. Cubit gives off value on aspect ratio too. Abaqus and Hypermesh agree on min angle but not on max angle.

A few more elements were investigated and self-intersections on elements were noticed. Don’t have an answer why Hypermesh and Cubit gives different values so far, need additional time to dig in.

Best guess is Hypermesh and abaqus calculates Jacobian differently with Cubit, maybe calculate with integration points rather than corner points: need to check formulations from documentations for both softwares if available.

Can’t rely on Cubit’s mesh quality check to automatically improve the mesh quality before it can be tuned up to be consistent with Abaqus.