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FINITE ELEMENTS ANALYSIS OF CORRODED VESSEL AREA

PROBLEM DESCRIPTION:

The 72" diameter cylindrical shell fabricated out of 1-1/4% Chrome and ½% Molybdenum alloy experienced significant generalized corrosion near a major nozzle. The concern was if the cylindrical shell needed to be repaired immediately or can it be operated for some more time. The conventional calculations indicated that the actual thickness was below the minimum allowable thickness. The Process engineering department was not willing to allow any de-rating of the vessel.

The fitness-for-service evaluation was performed using Finite element analysis to check for continued future operation of the vessel.

FEA MODEL & RESULTS:

The Finite elements analysis was performed using FEA software ANSYS.

The 3-D model of the cylindrical shell along with the 10" nozzle with reinforcing pad was generated using FEA software ANSYS. The 8'-8" high corroded vessel shell was modeled with 220 corroded area zones consisting of 22 area zones in horizontal direction and 10 area zones in vertical direction. The thickness value for each area zone was actual measured thickness minus the expected C.A. (0.020") over future one year of operation. The additional uncorroded areas with 50" height were modeled at the top end and the bottom ends. A hemispherical pipe cap was added to the end of the nozzle to remove the nozzle effect on the vessel stresses.

Two load cases were analyzed using the finite element analysis. For both the load cases, the pressure loading of 400 psig was applied to the inside of the cylindrical shell and the 10" dia. nozzle. For load case - 1, the thickness of each corroded area zone was modeled with actual measured thickness minus the 0.020" future corrosion allowance. The Von Mises stress criteria was used for checking the stresses as compared to the allowable stresses.

Based on the FEA results, it was found that for Load Case-1, the maximum stresses present in the cylindrical shell region of the vessel were not in compliance with ASME B&PV Code, Section VIII, Div.-1.

To bring the stresses in ASME Code compliance, it was decided to patch the corroded area of the vessel with 0.500" thick plate by welding on the inside of the corroded plate. Thus for load case - 2, the thickness of each corroded area zone was modeled with actual measured thickness minus the 0.020" future corrosion allowance plus the 0.500" thickness for the patch plate.

Based on the revised results of the three dimensional finite element analysis, the repaired vessel (as per repairs listed above) is in compliance with ASME B&PV Code, Section VIII, Div.-1.

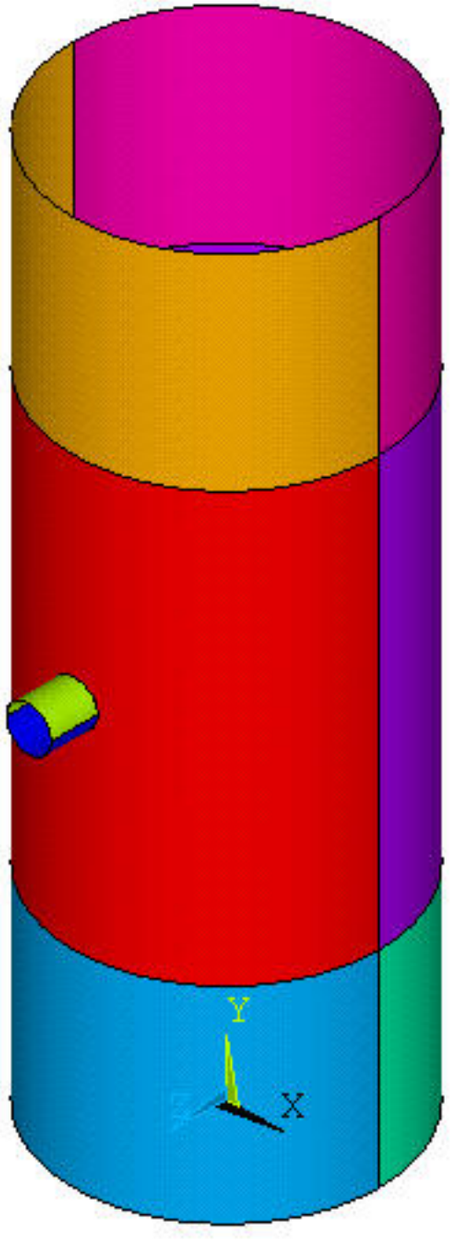
The attached FEA plots show the FEA model and results for the Load case - 2.

1

AREAS

AREA NUM

ANSYS



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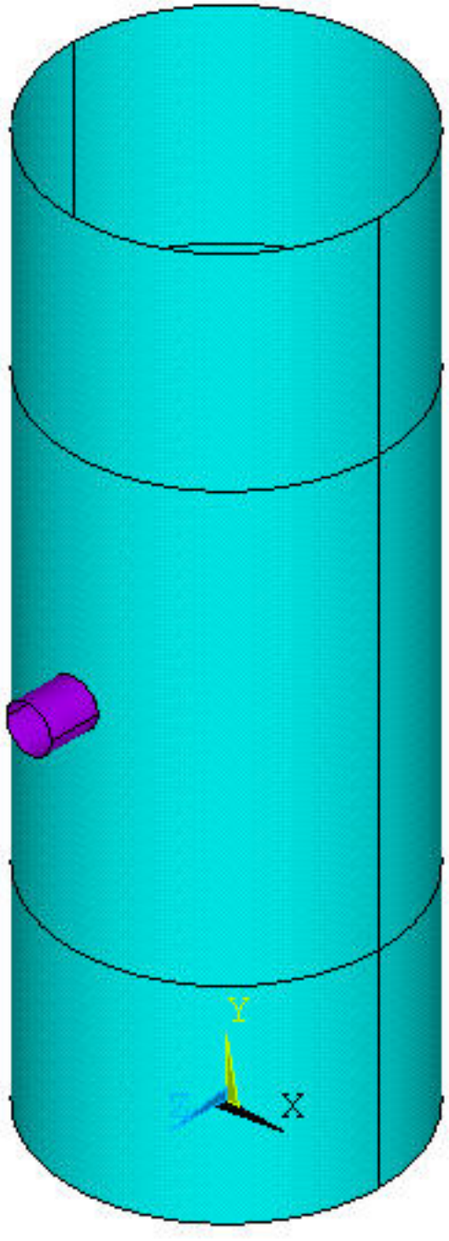

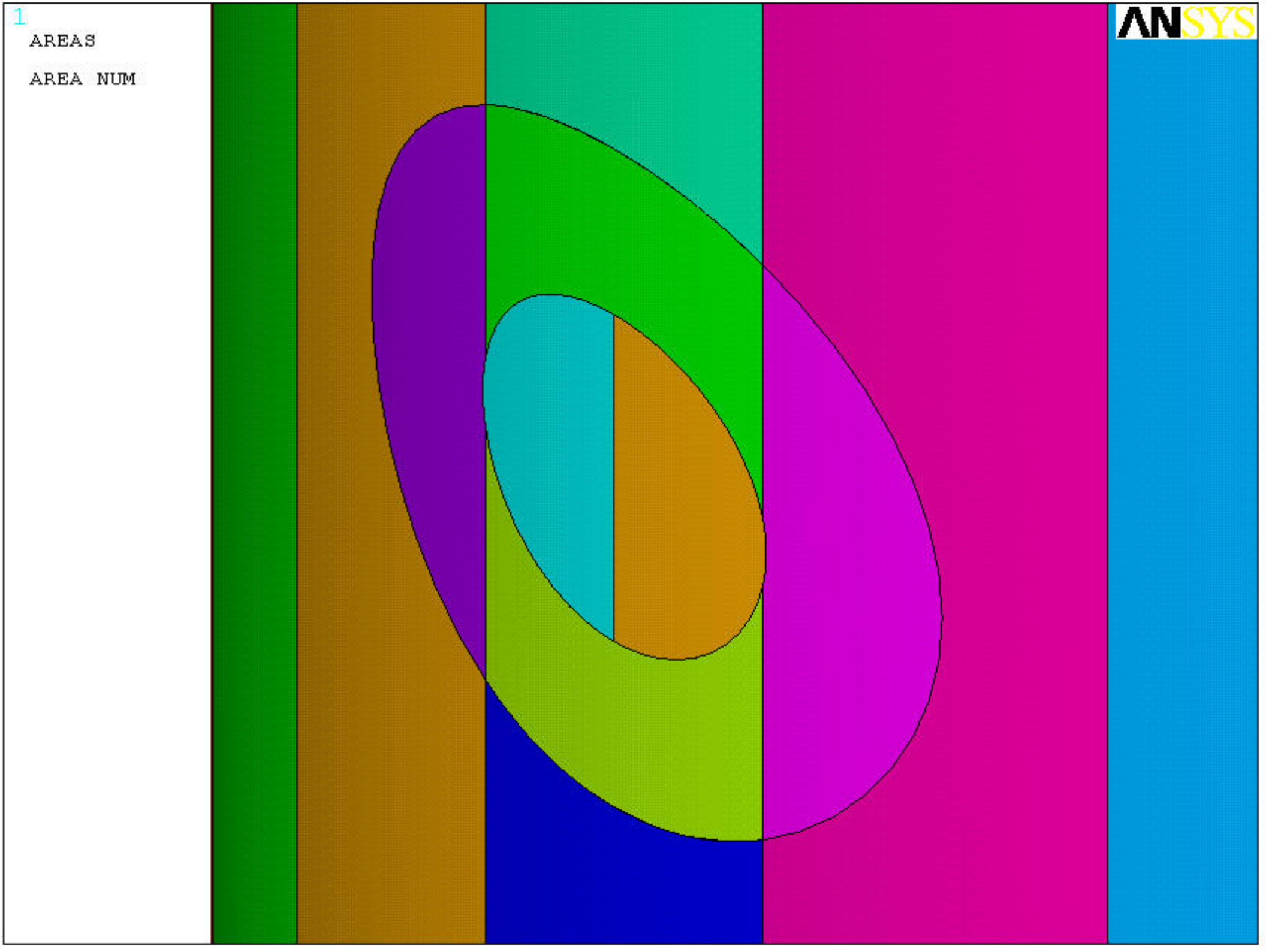
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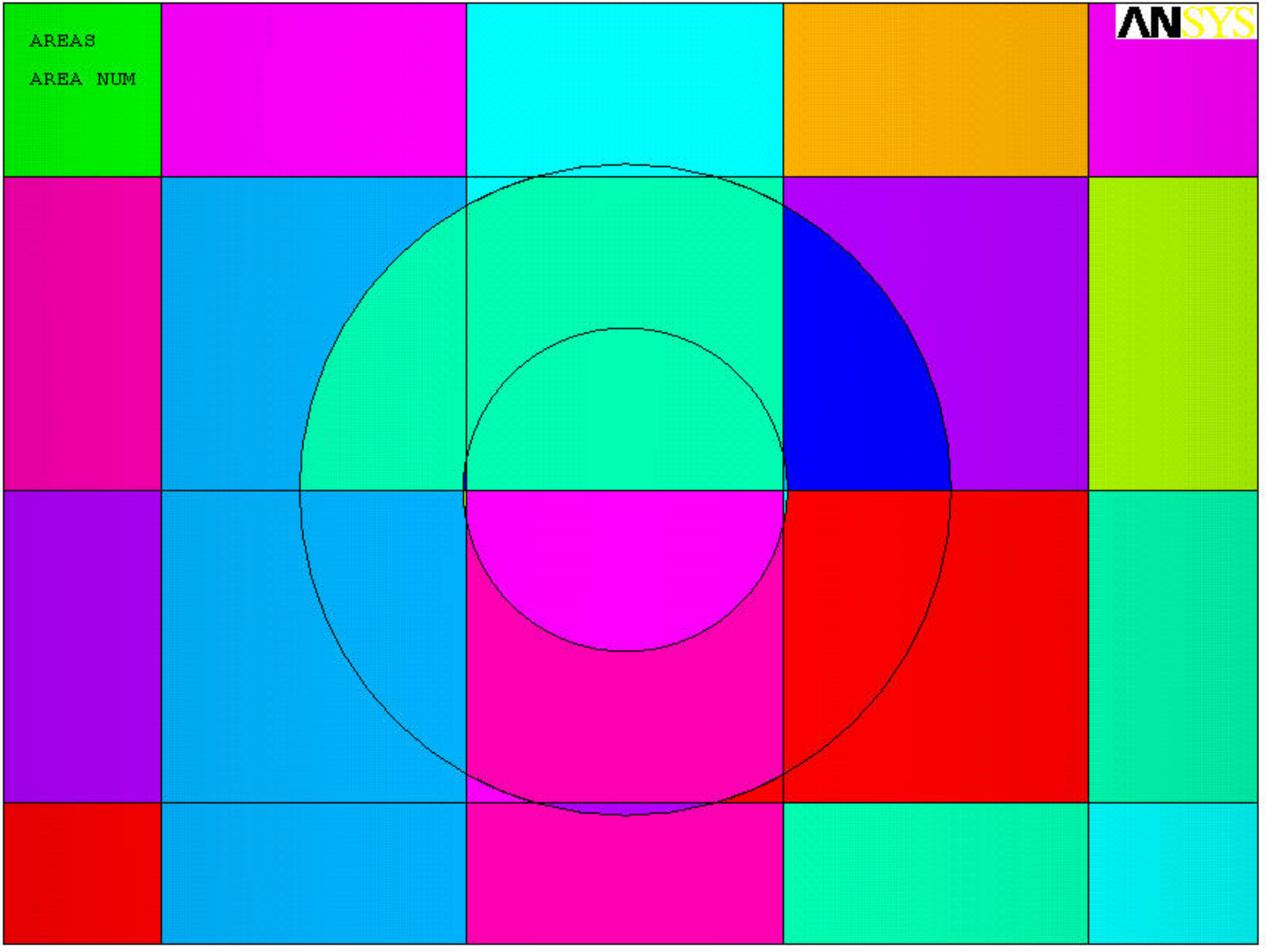
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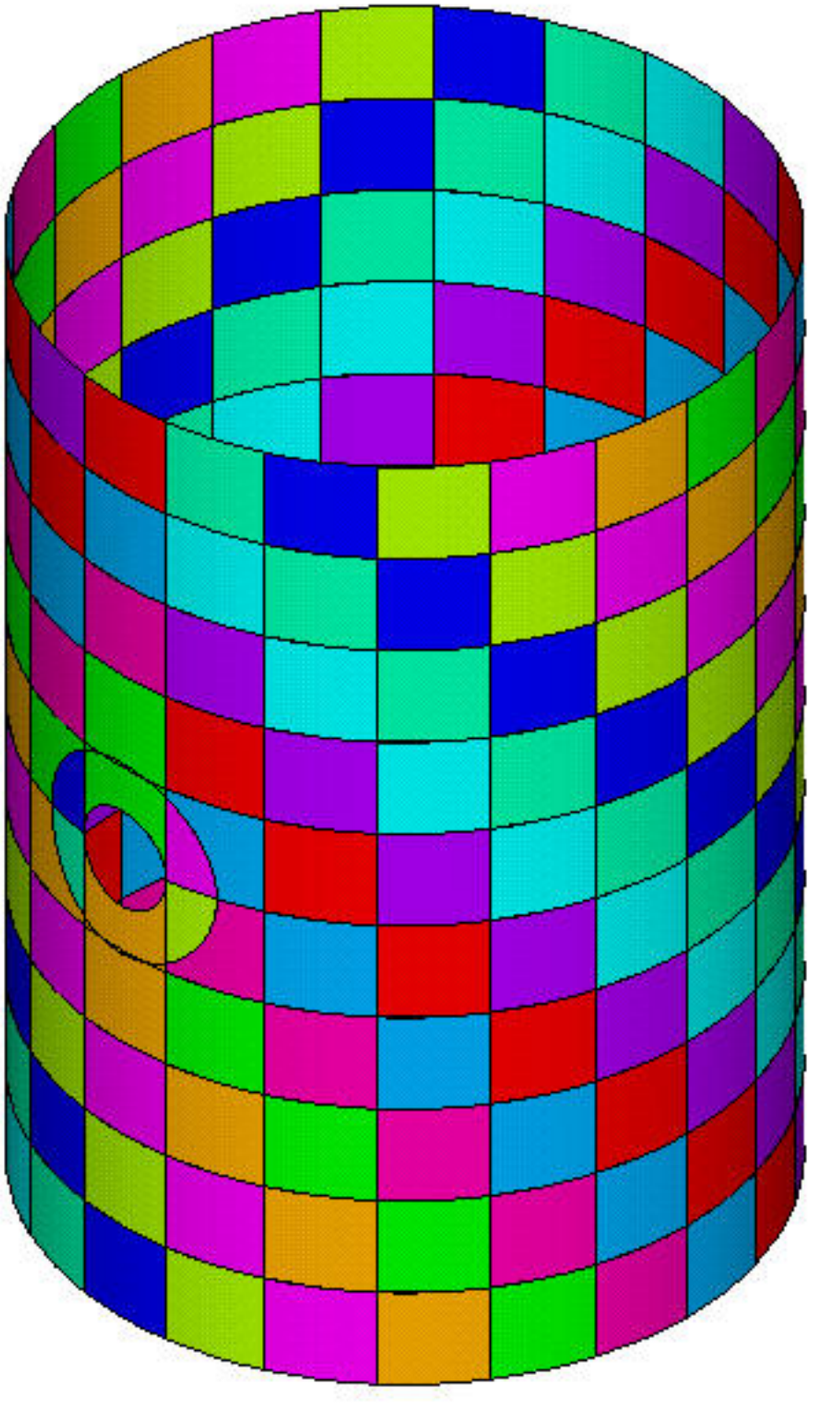

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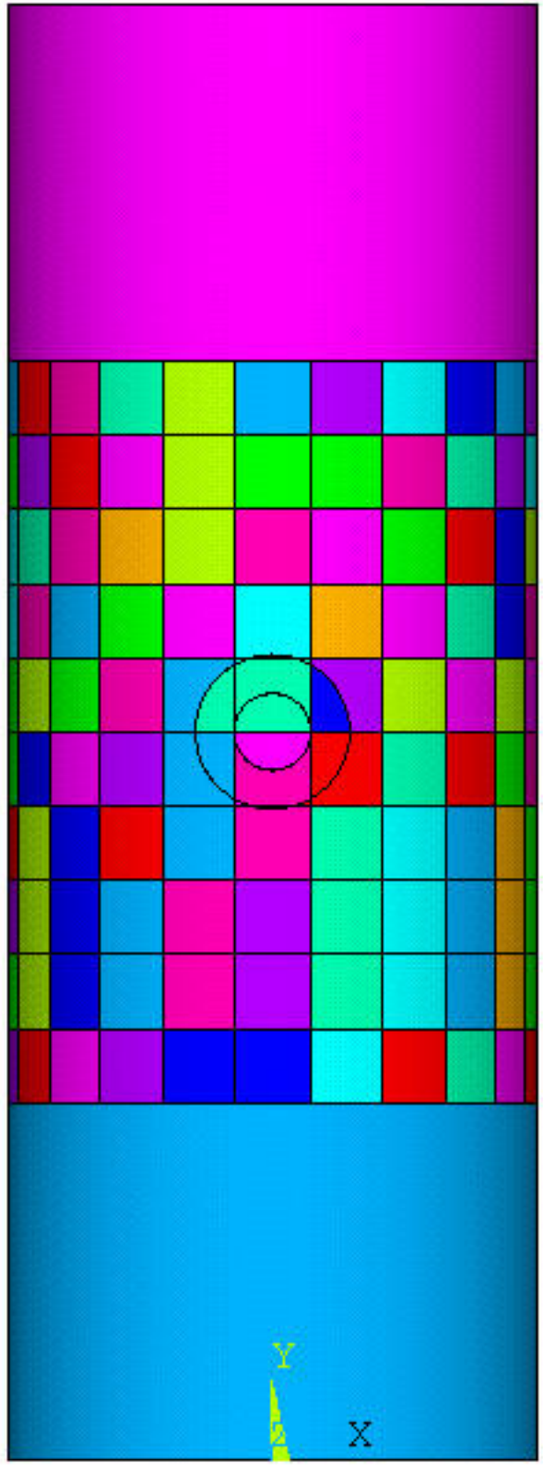

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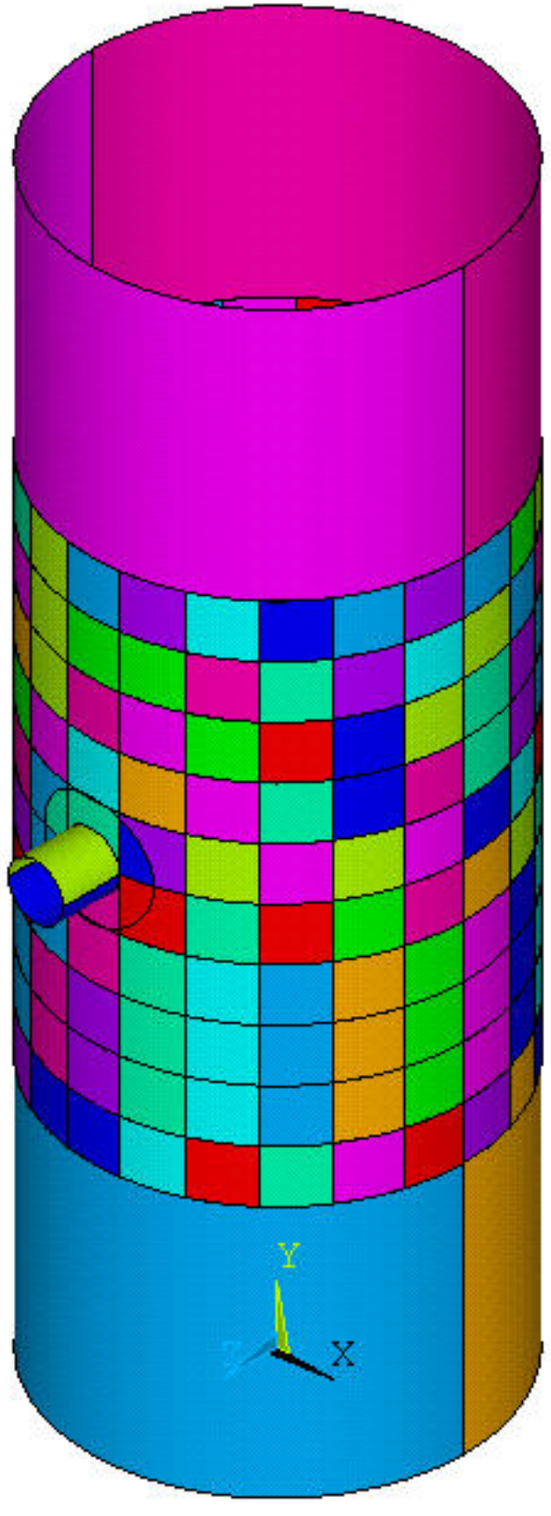

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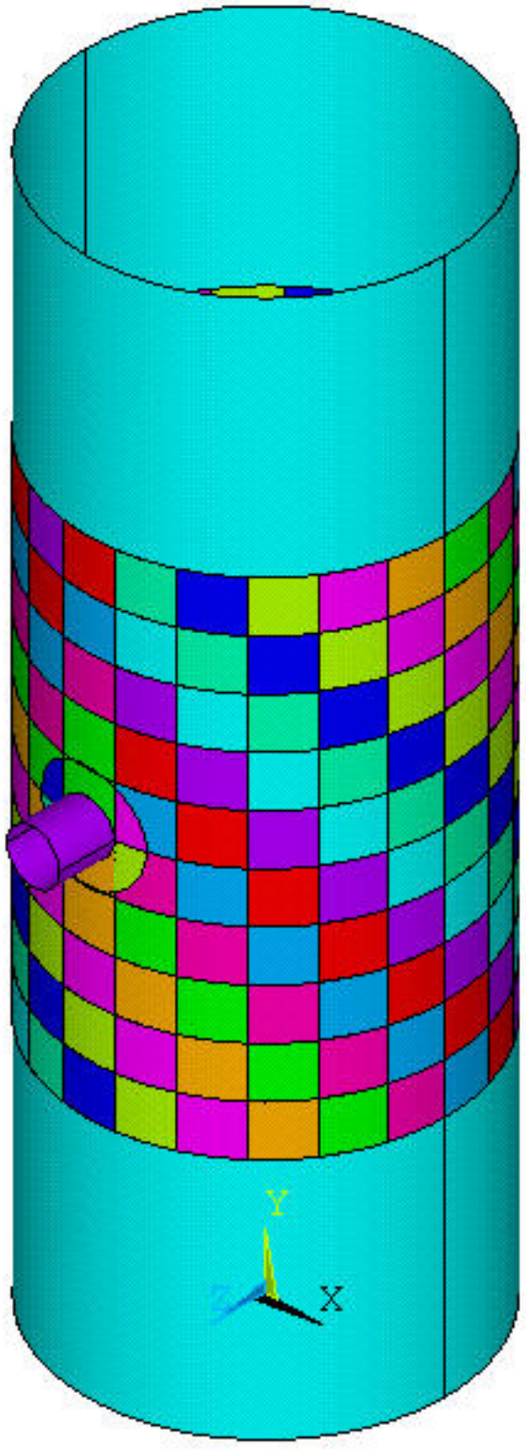

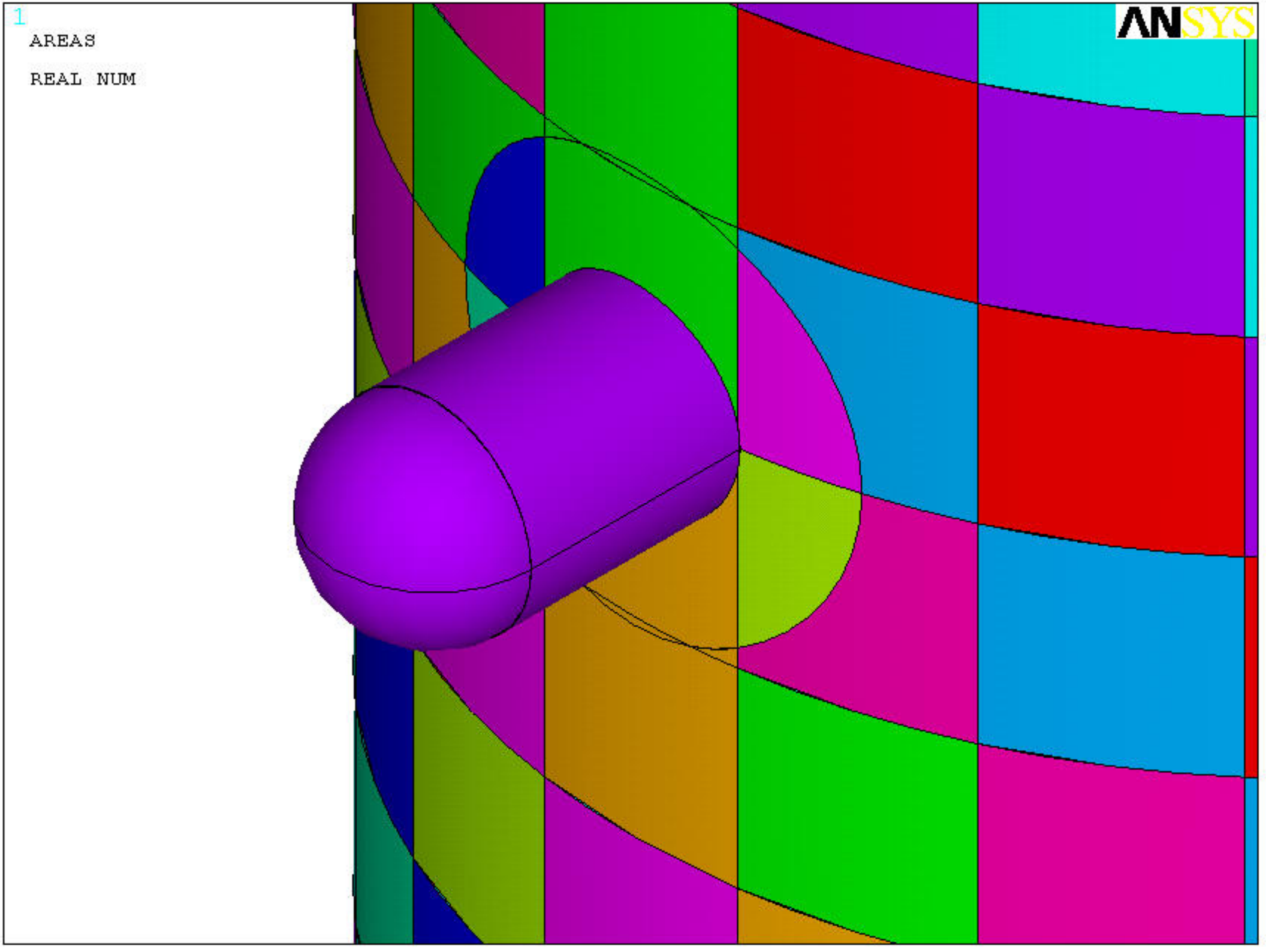
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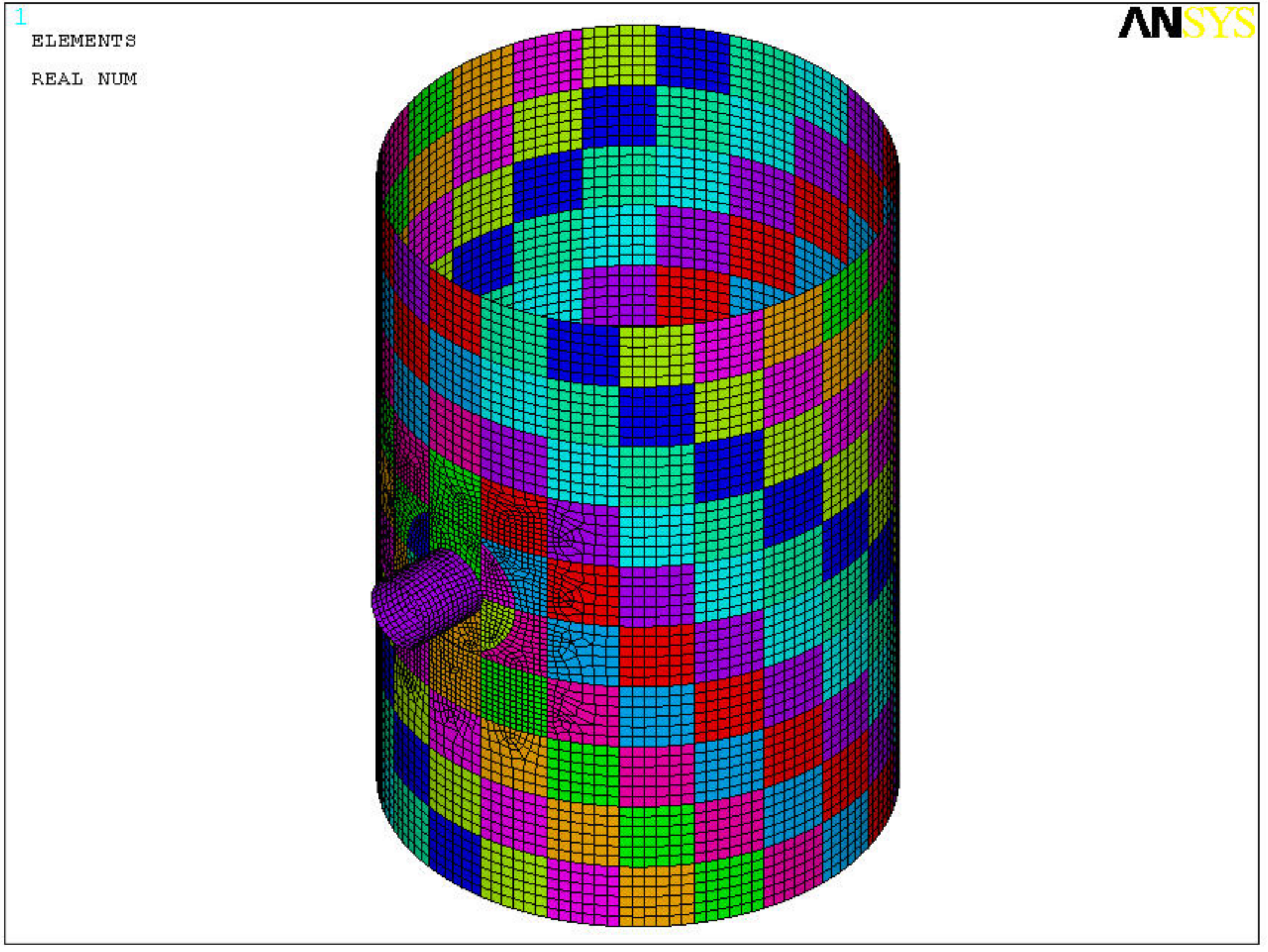
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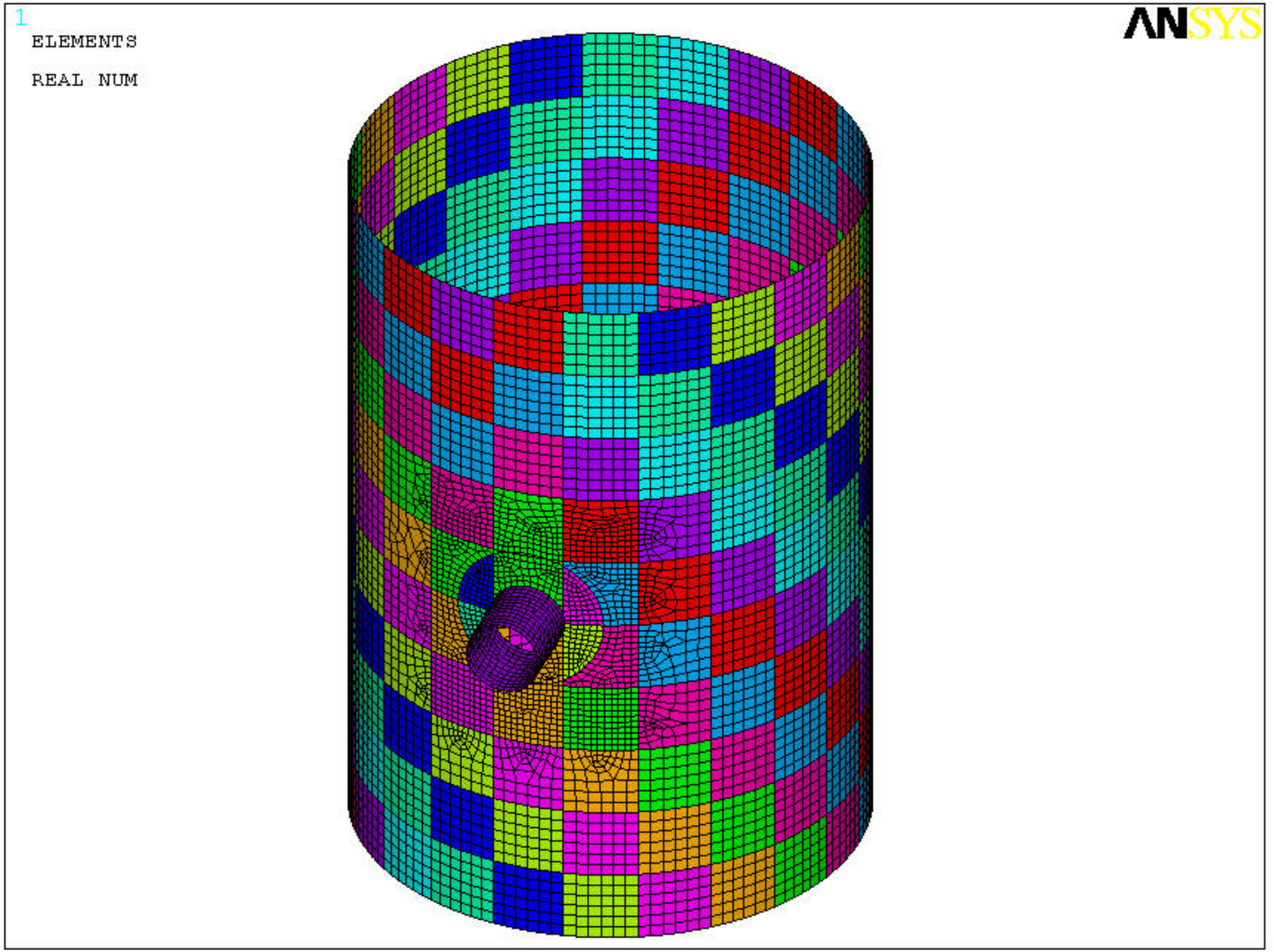
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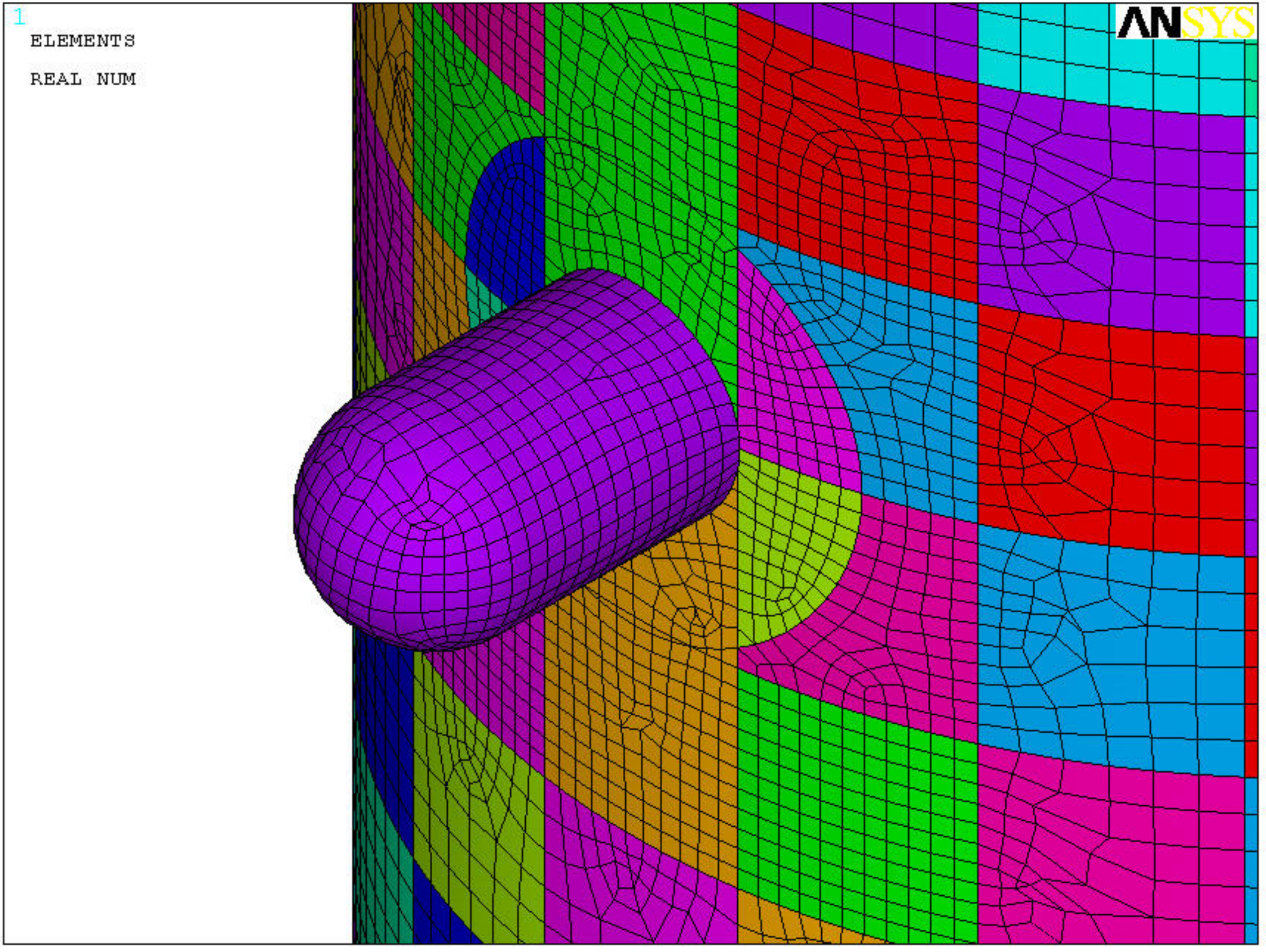
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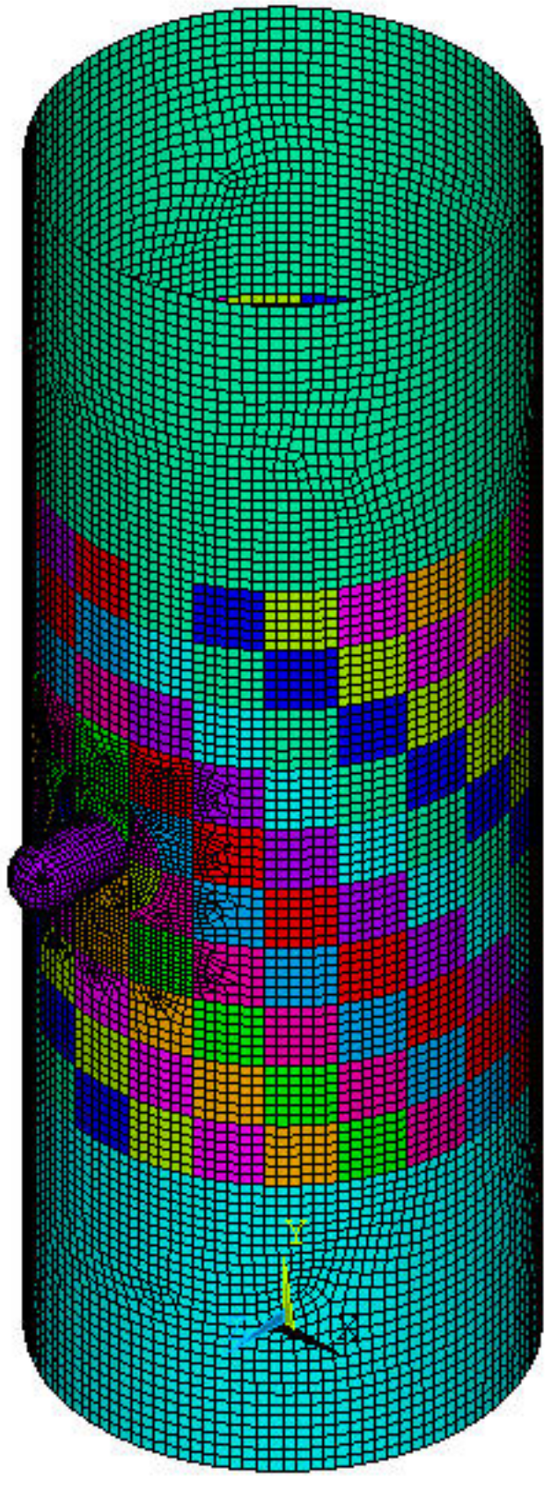

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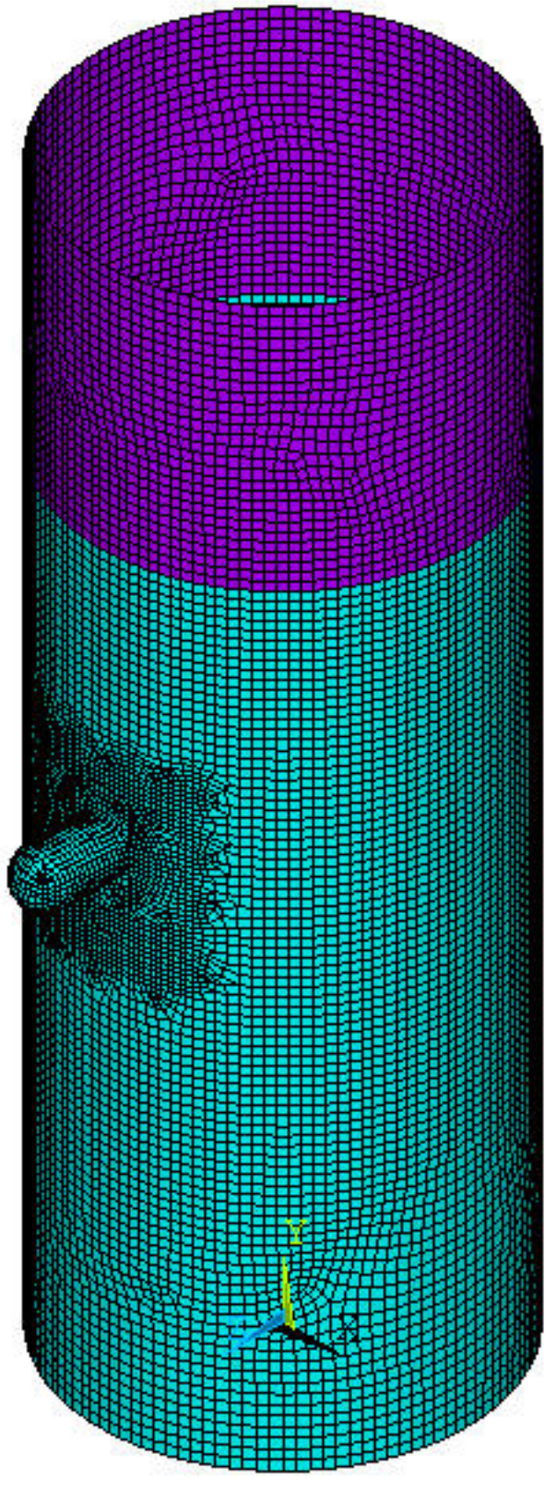

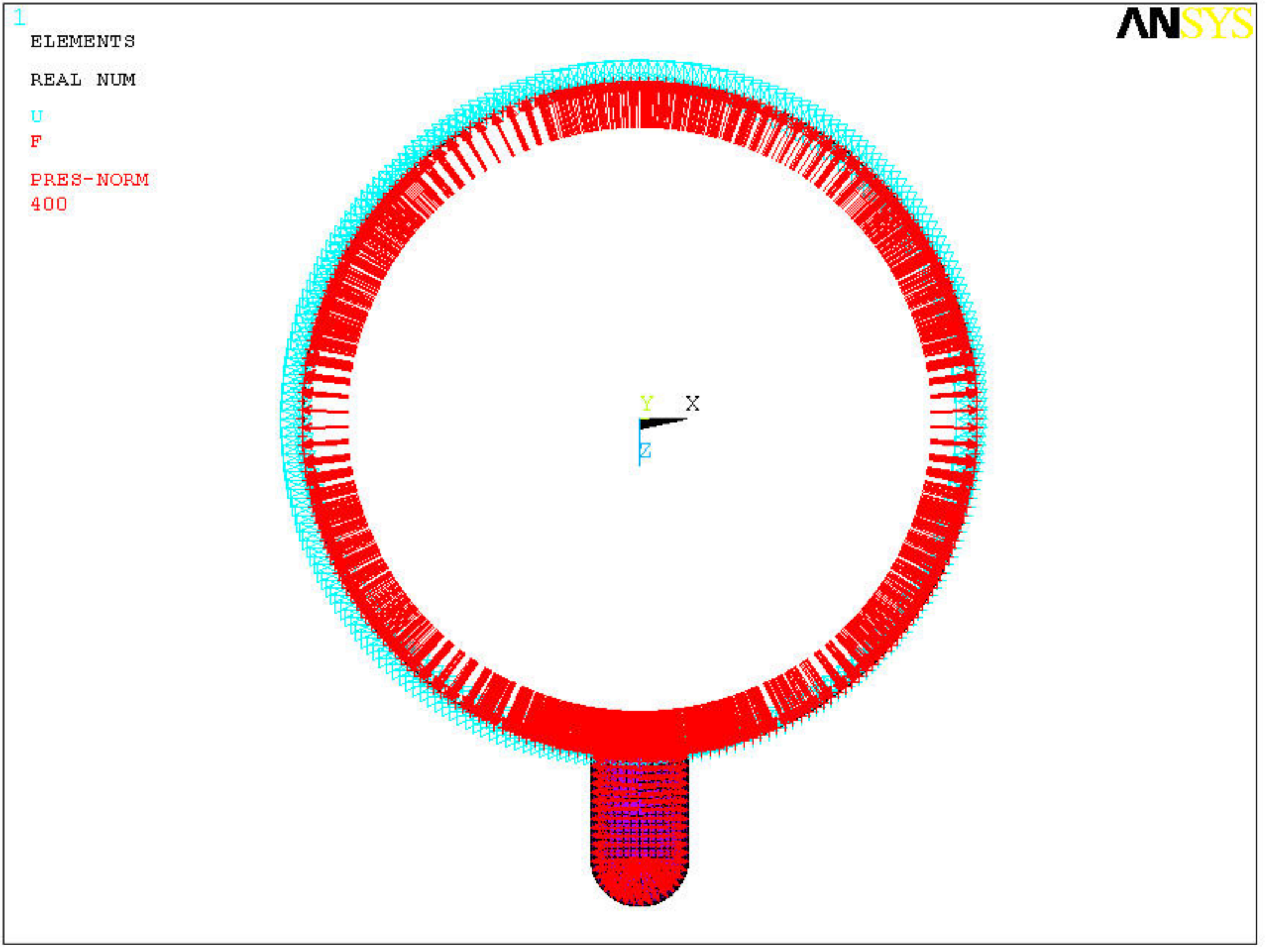
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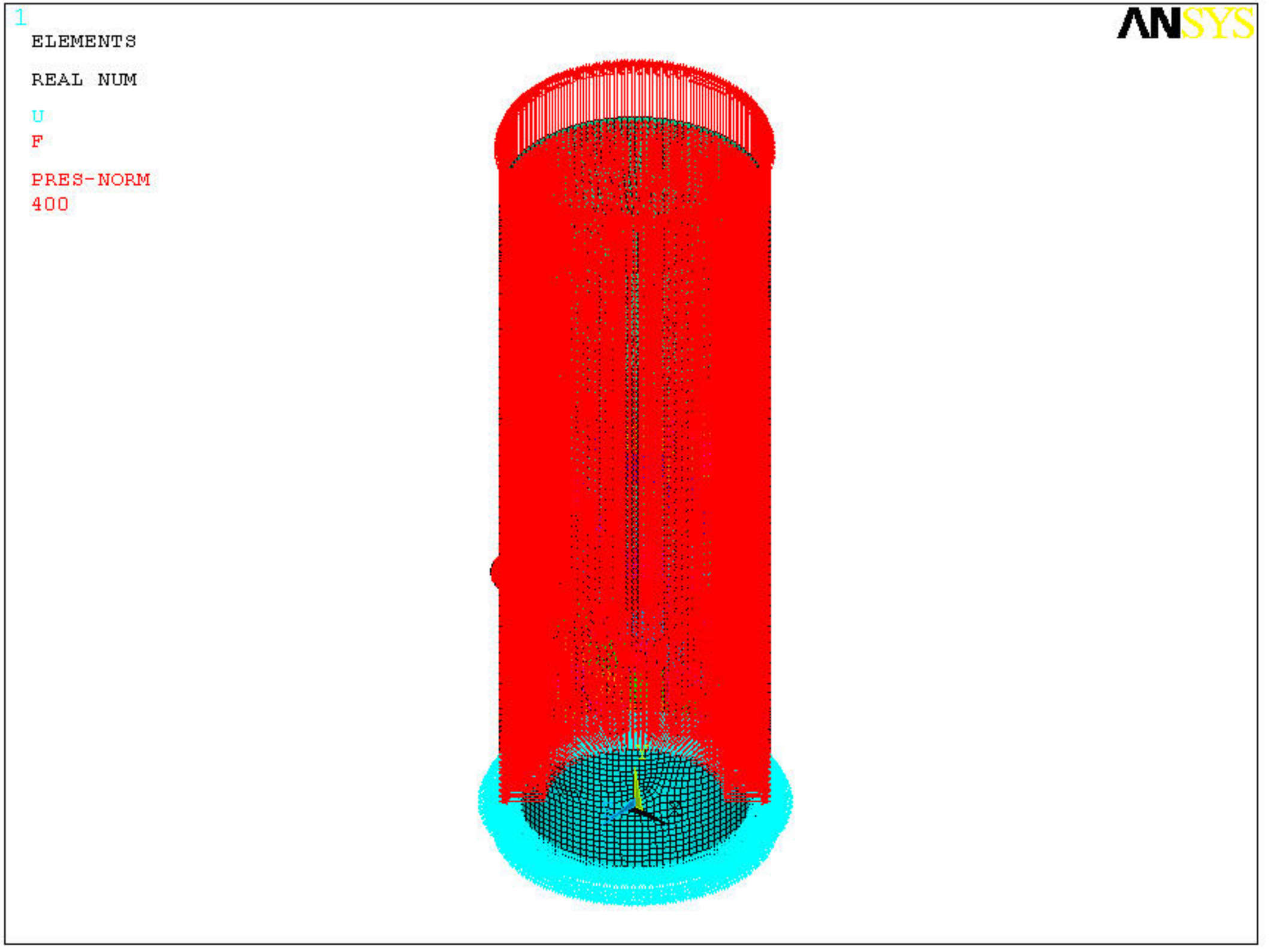
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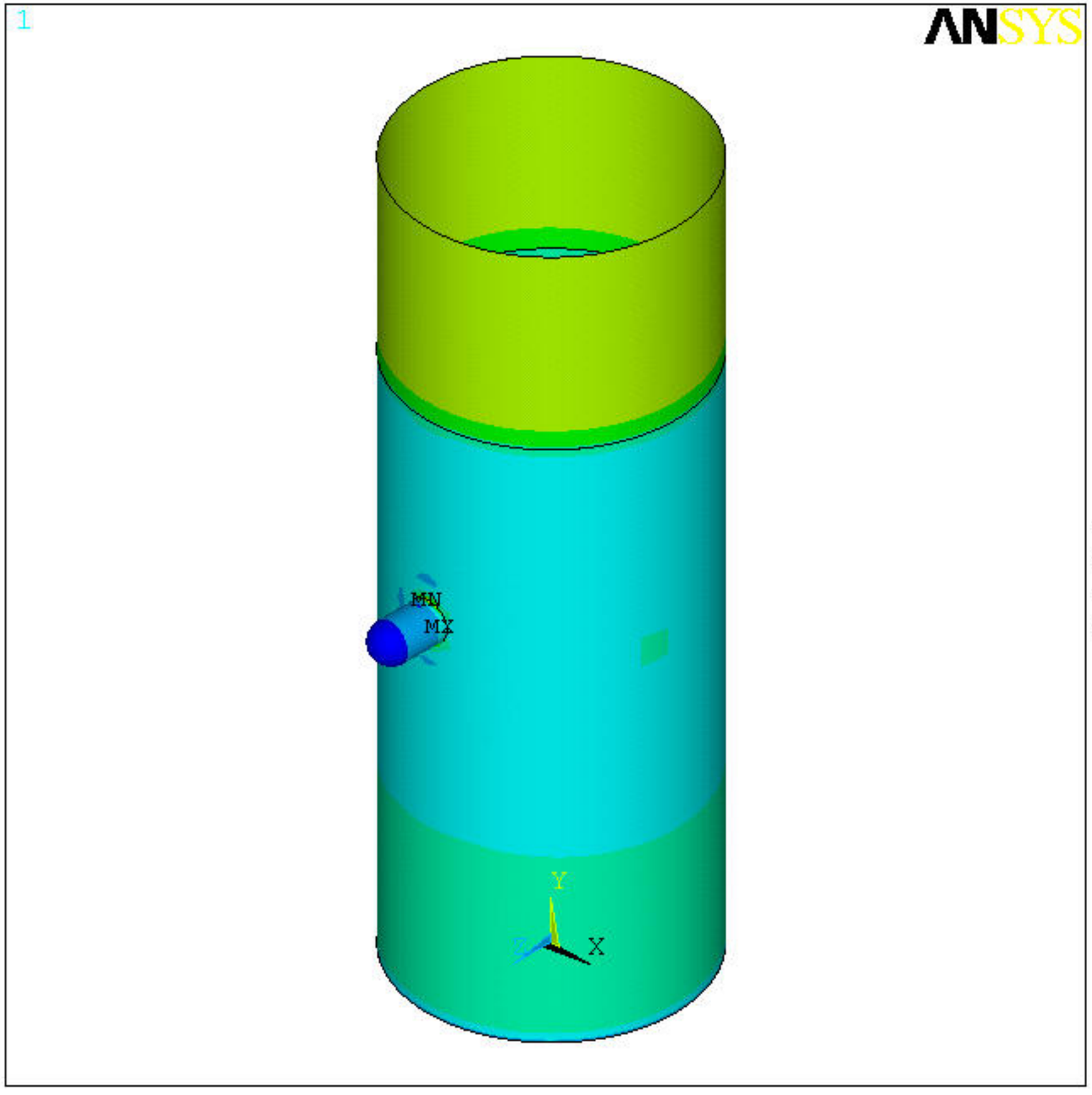
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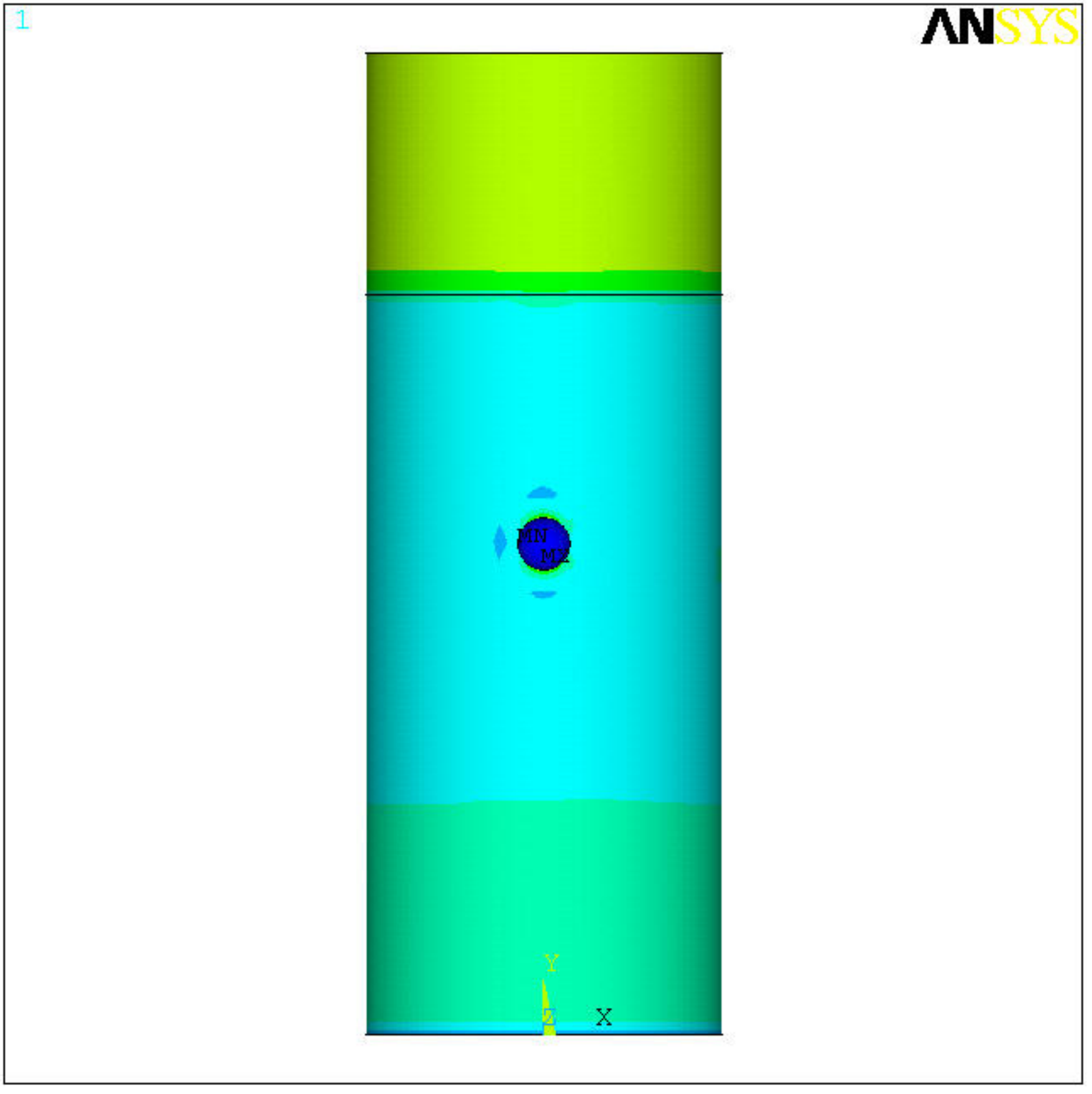
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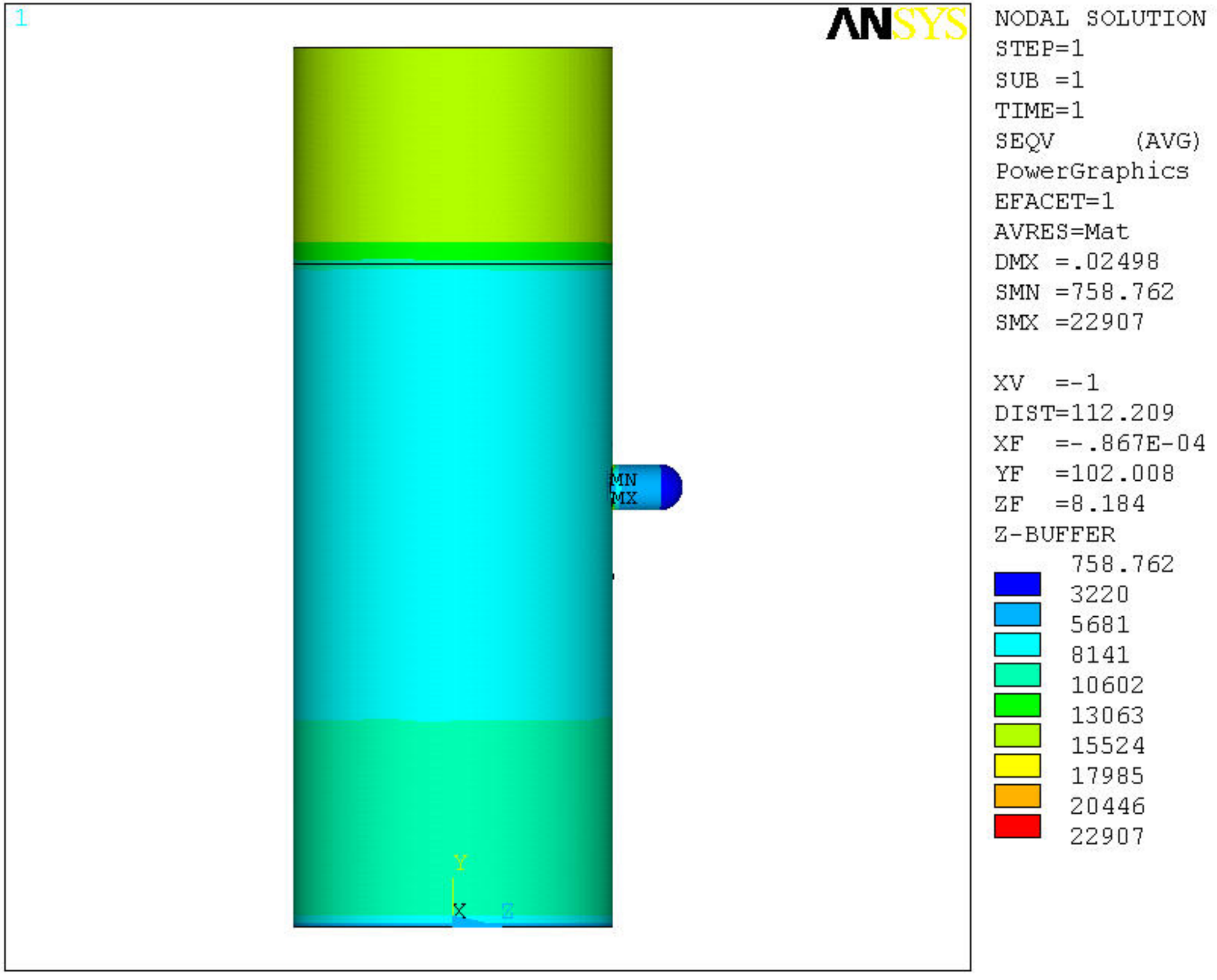
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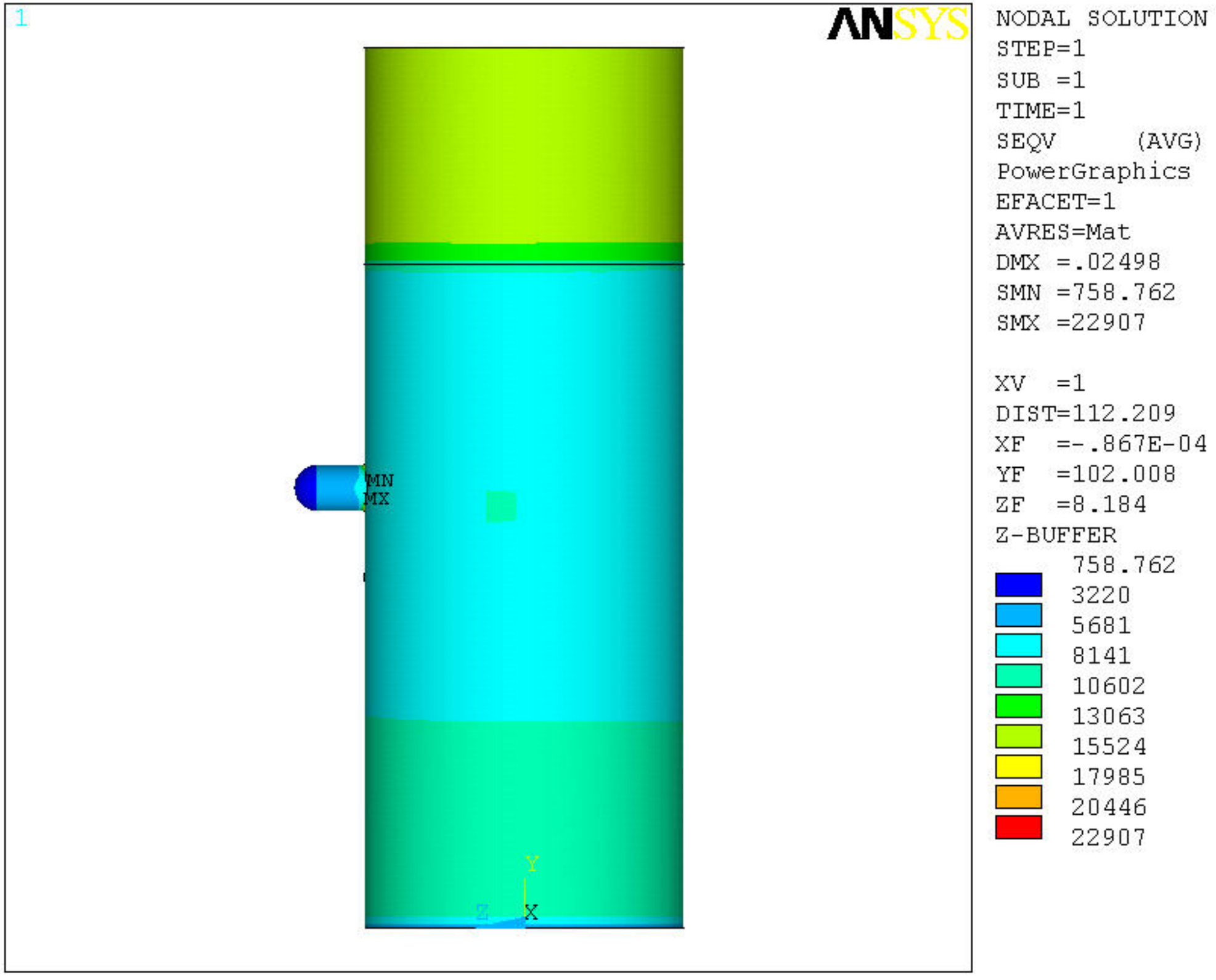
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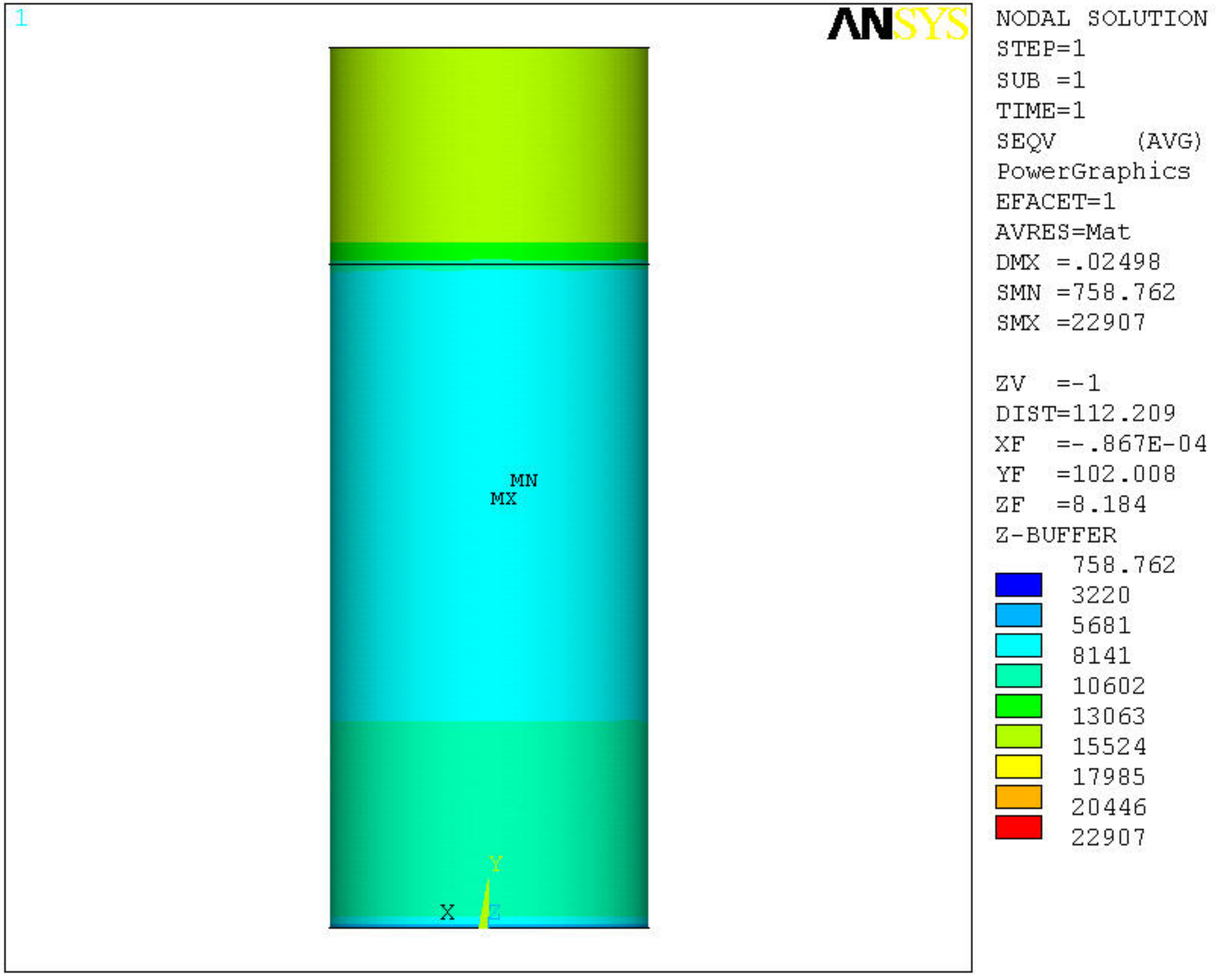
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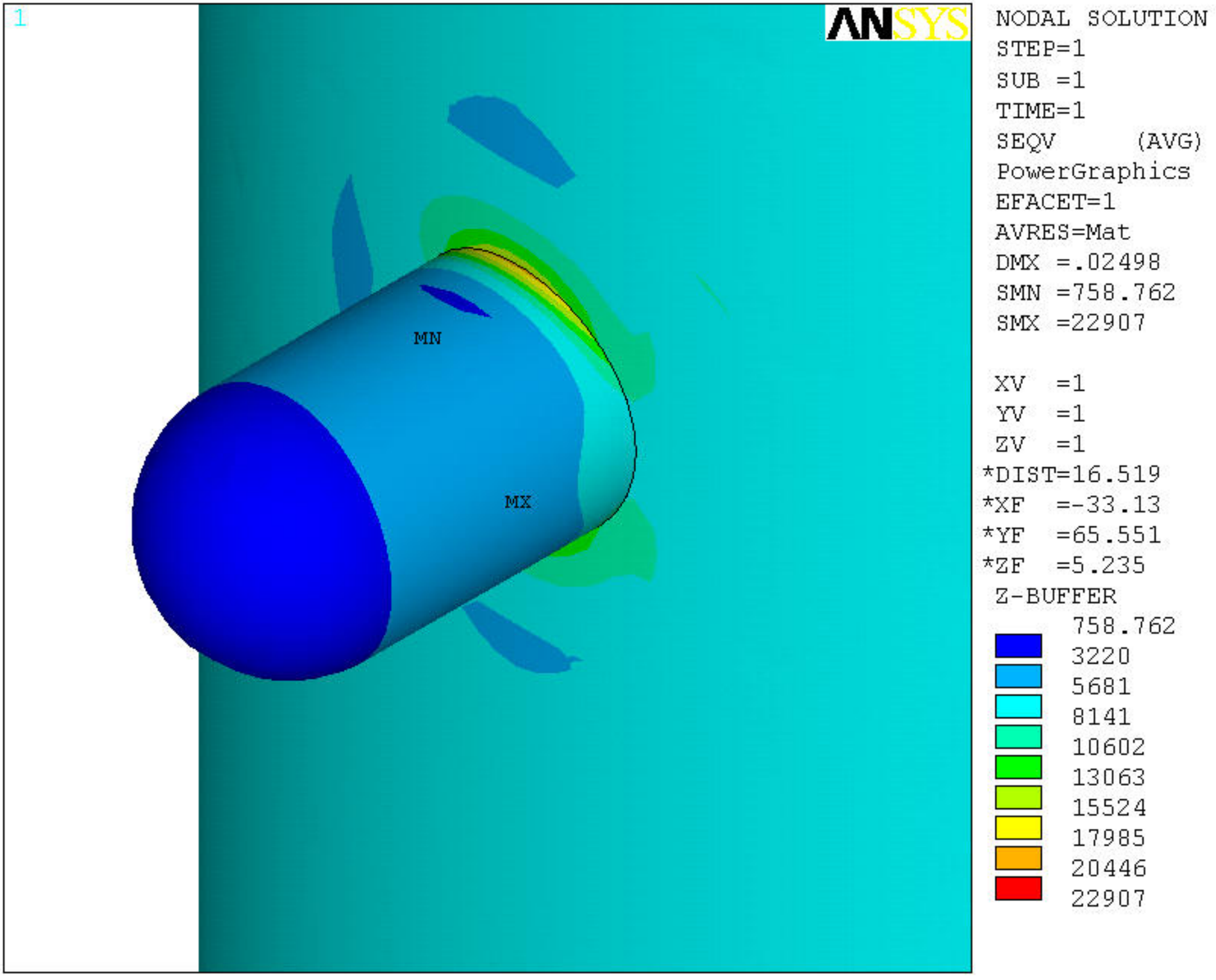
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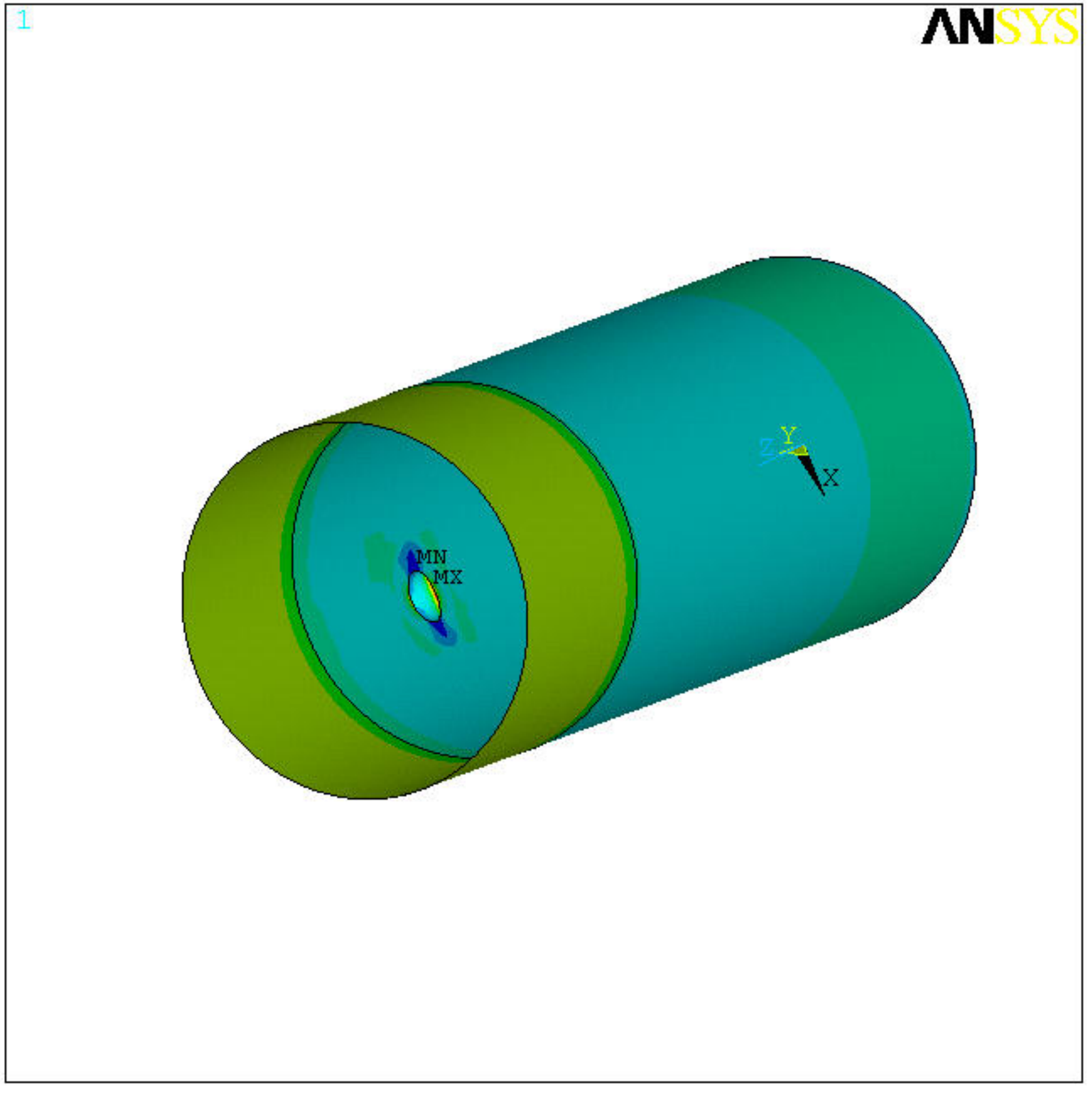
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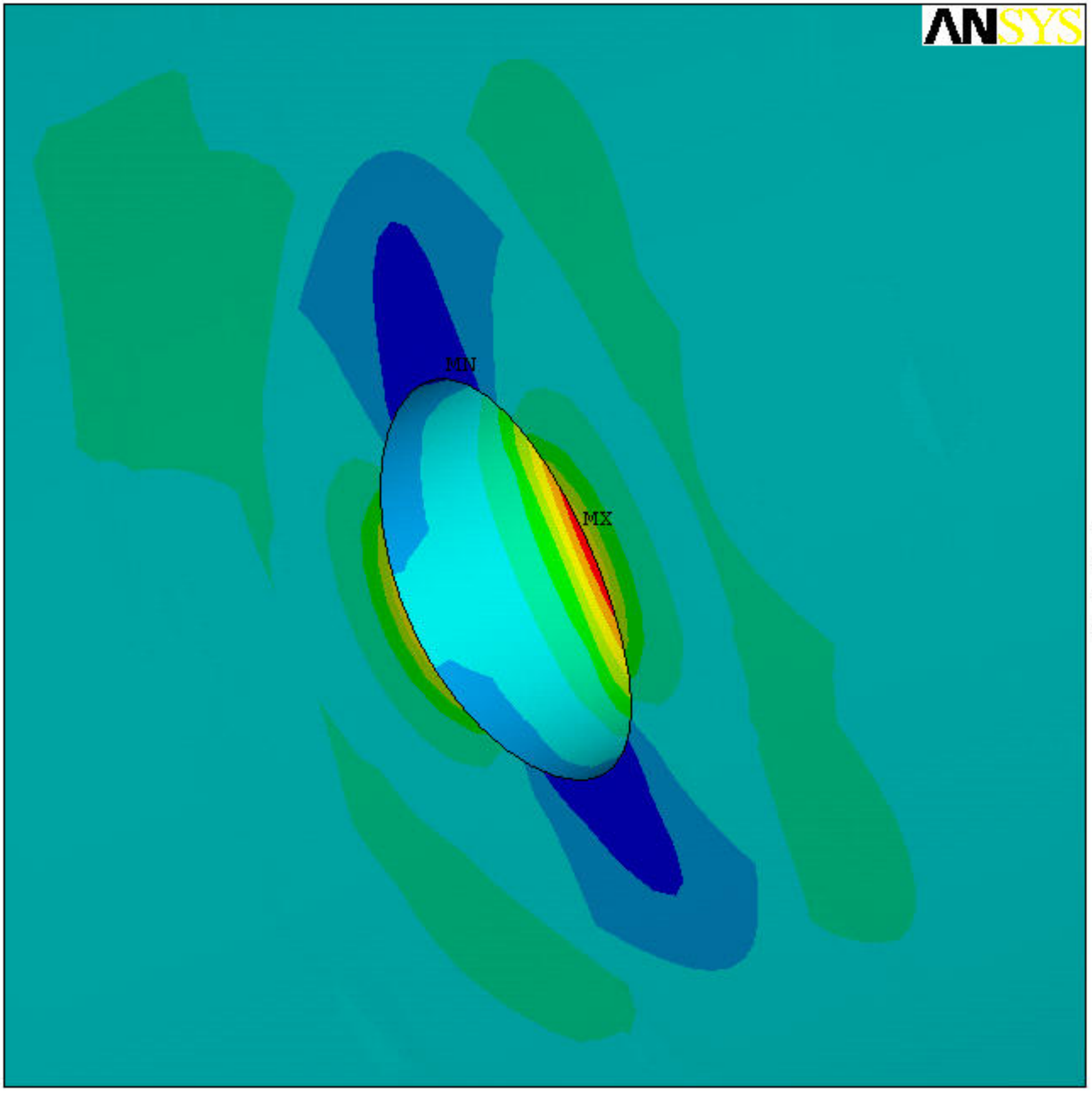

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