

## **PRESSURE EQUIPMENT ENGINEERING SERVICES, INC.**

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### **FINITE ELEMENTS ANALYSIS OF FRP SUPPORT STRUCTURE OF A COOLING TOWER**

#### **PROBLEM DESCRIPTION:**

It was required to perform the design of multiple FRP support beams (Beam Material: Isophthalic Polyester FRP) used in cooling tower support structure for compliance with Cooling Technology Institute standards and structural engineering principles.

For each concrete bay of the cooling tower, the cooling tower support structure consisted of two sets of 26 beams each. These were uniformly supported by eight (8) concrete beams. At the two end locations, the FRP beams were bolted to the concrete beams. The middle locations of the FRP beams were vertically supported on the concrete beams.

It was required to perform the design check using finite element analysis.

#### **FEA MODEL & RESULTS:**

As the FRP beams were uniformly spaced, it was decided to model one FRP beam with the eight (8) support zones. The three dimensional FEA model of the FRP beam and the eight (8) support zones was created using finite element analysis software ANSYS. Three different loading combinations were analyzed. The analyzed loading combinations involved application of appropriate dead load, live load and fouling load to the FEA model.

For all the loading combinations analyzed, the stress analysis results for the FRP structure were checked against the allowable stresses. The stress and displacement results were found to be acceptable per Structural engineering practices.

Based on the results of the three dimensional finite element analysis, the design of the FRP beams was found to be adequate to support the combination of dead load, live load and fouling load.

The attached FEA plots show the model and results for one of the loading combinations analyzed.

1

ANSYS

NODAL SOLUTION

STEP=1

SUB =1

TIME=1

SEQV (AVG)

TOP

DMX =.012944

SMX =1146

XV =1

YV =1

ZV =1

\*DIST=13.073

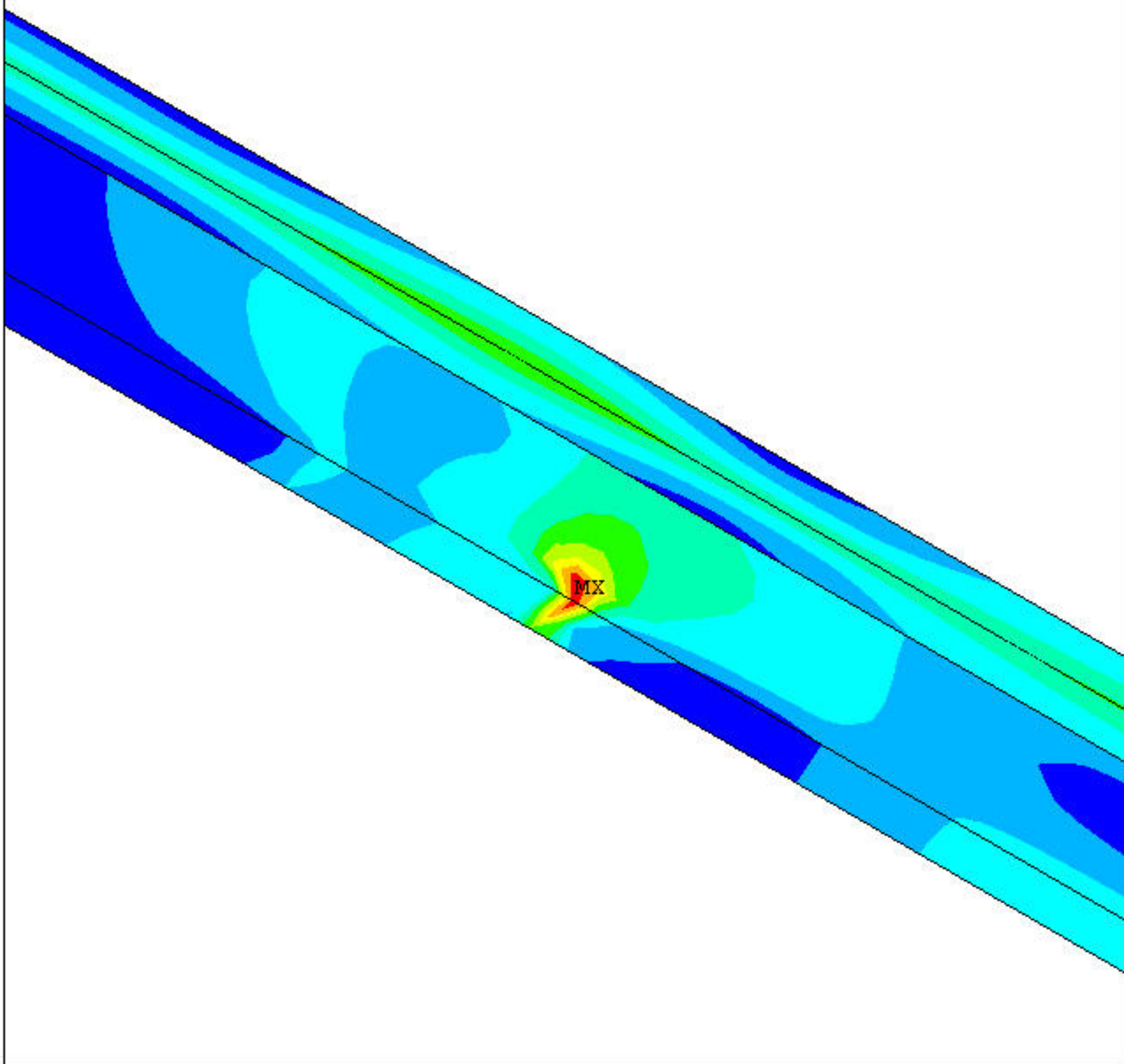
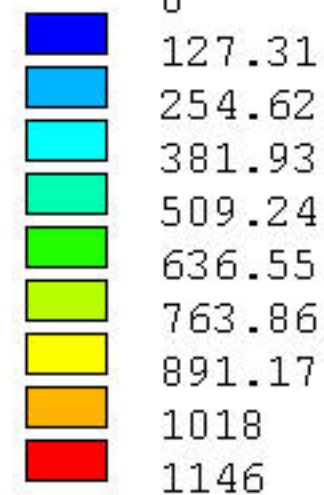
\*XF =100.962

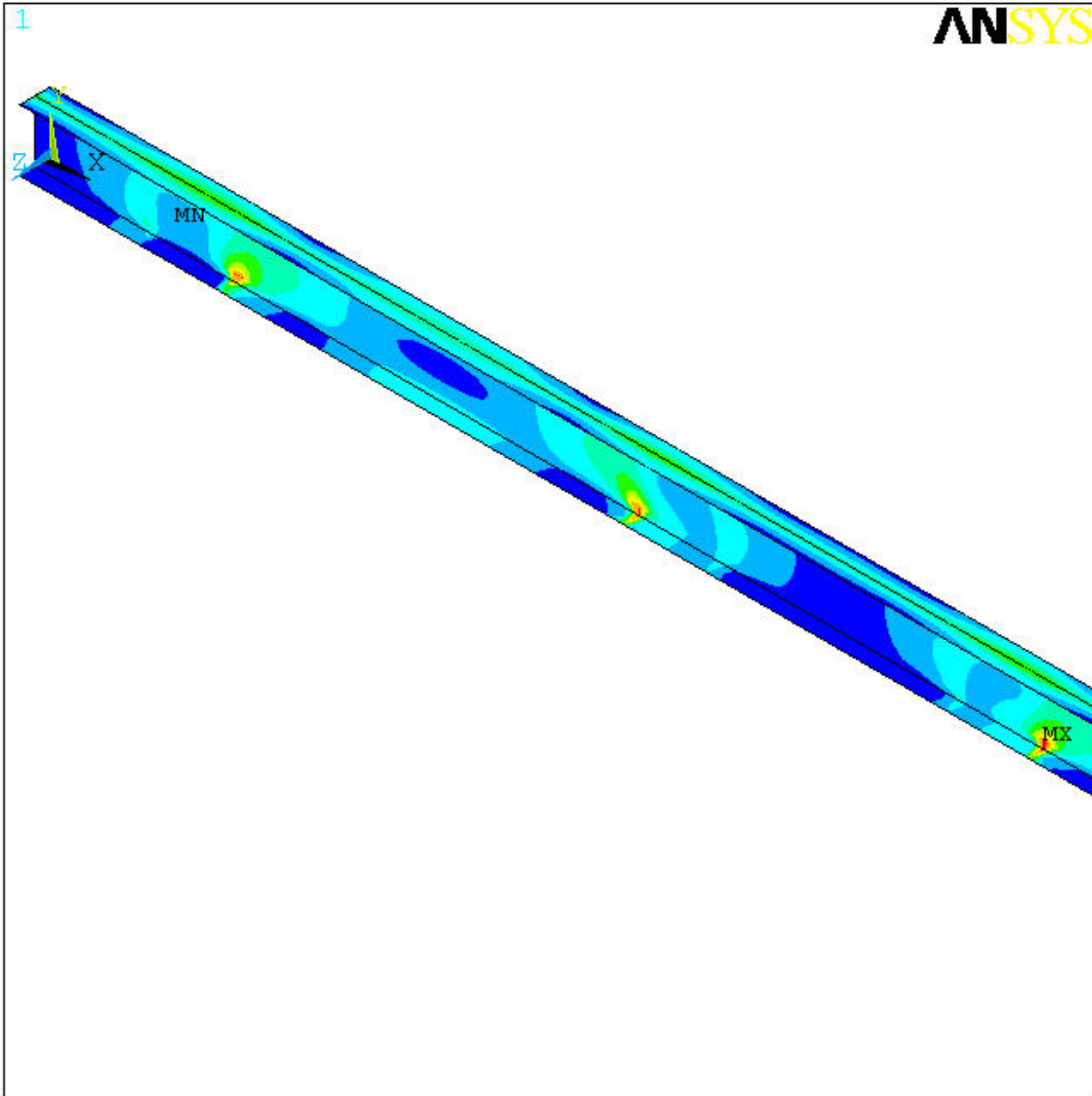
\*YF =5.72

\*ZF =4.519

Z-BUFFER

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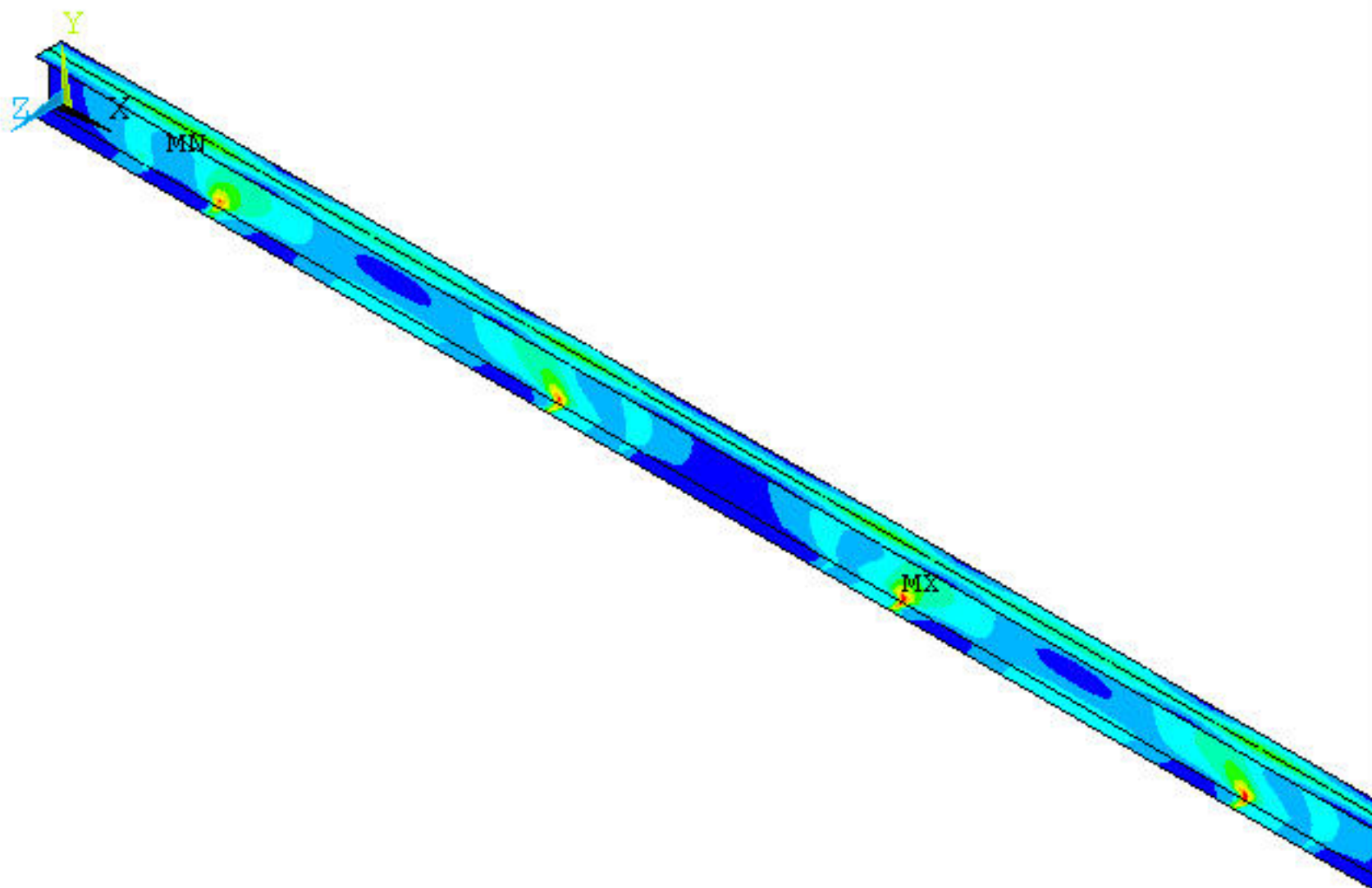




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 TIME=1  
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 TOP  
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 SMX =1146  
  
 XV =1  
 YV =1  
 ZV =1  
 \*DIST=37.618  
 \*XF =56.413  
 \*YF =-1.058  
 \*ZF =7.681  
 Z-BUFFER  
 0  
 127.31  
 254.62  
 381.93  
 509.24  
 636.55  
 763.86  
 891.17  
 1018  
 1146

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ANSYS



NODAL SOLUTION

STEP=1

SUB =1

TIME=1

SEQV (AVG)

TOP

DMX =.012944

SMX =1146

XV =1

YV =1

ZV =1

\*DIST=56.732

\*XF =75.662

\*YF =-4.534

\*ZF =4.519

Z-BUFFER

0

127.31

254.62

381.93

509.24

636.55

763.86

891.17

1018

1146

1

ANSYS

NODAL SOLUTION

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SUB =1

TIME=1

SEQV (AVG)

TOP

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SMX =1146

XV =1

YV =1

ZV =1

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YF =2.994

ZF =1.5

Z-BUFFER

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254.62

381.93

509.24

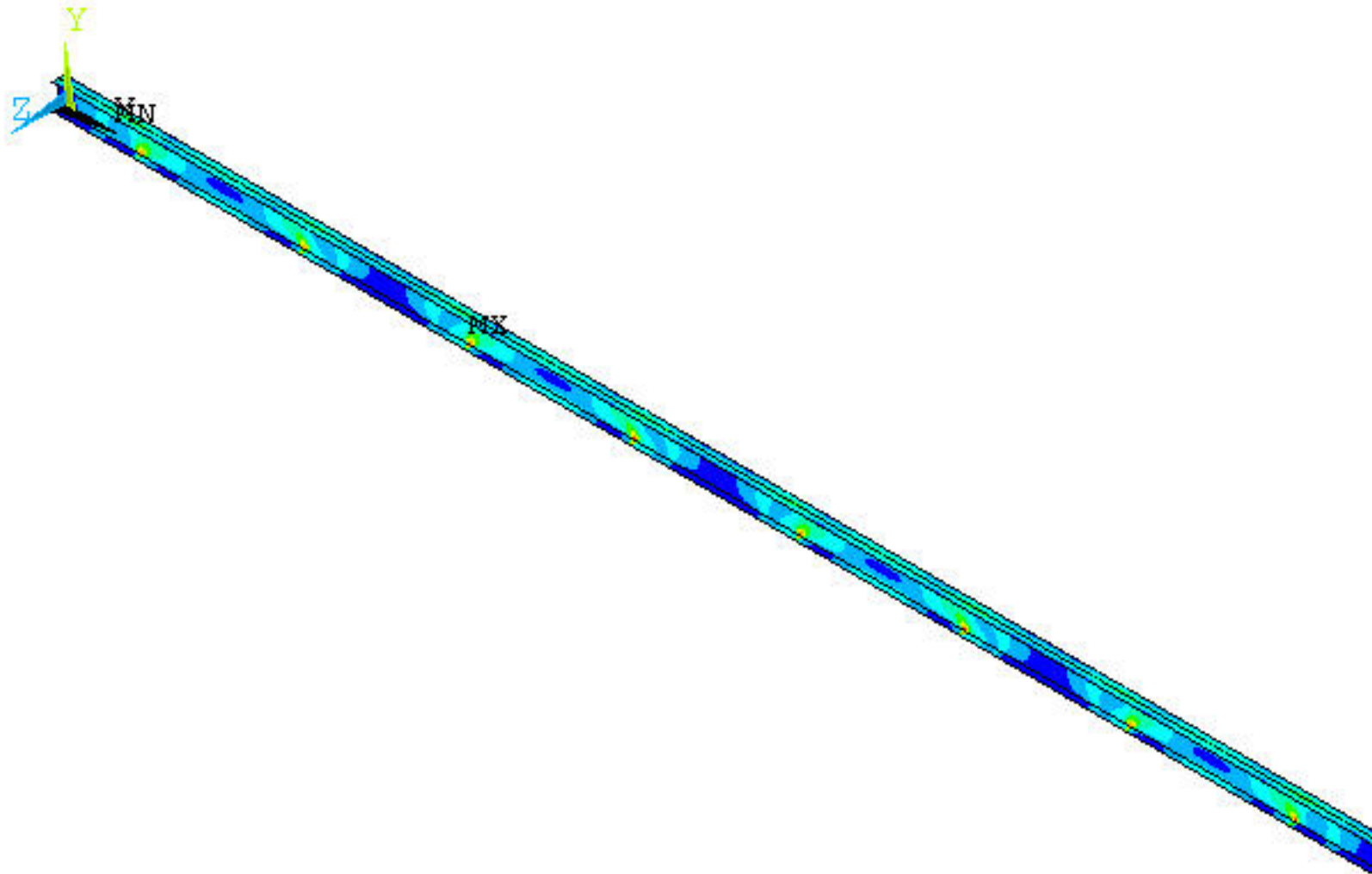
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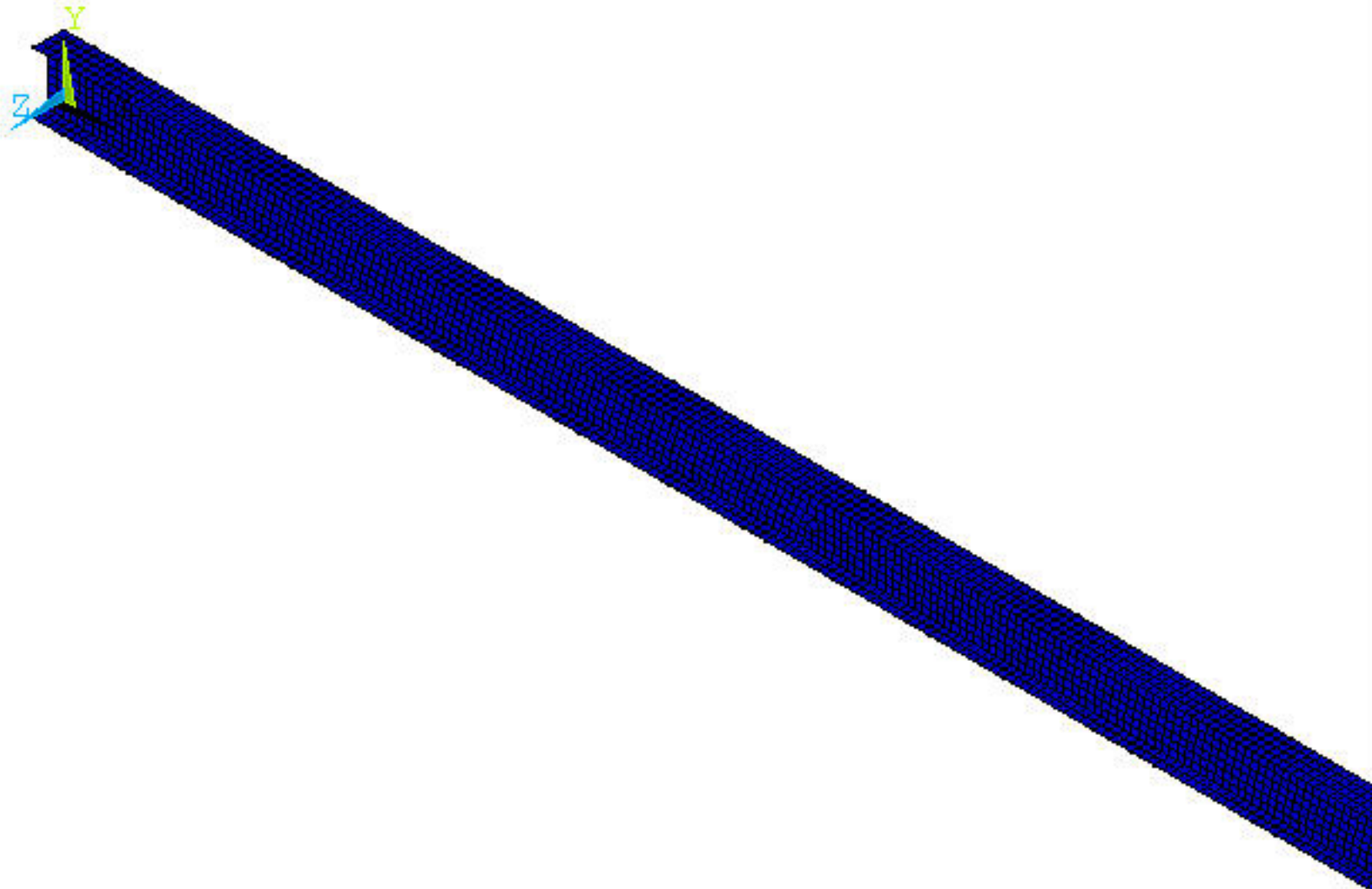
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ANSYS

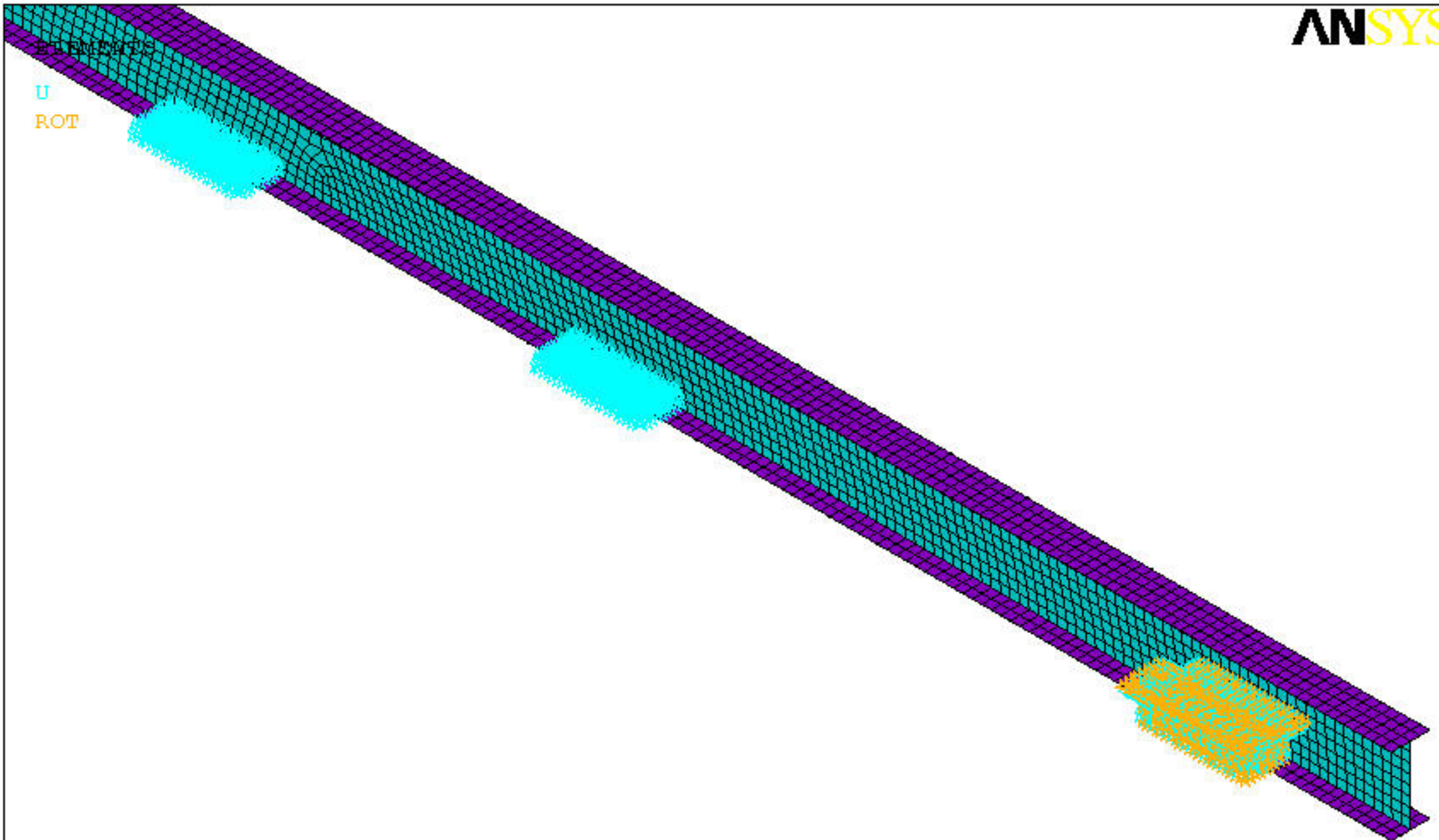


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TIME=1  
RSYS=0  
DMX =.012944

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XV =1  
YV =1  
ZV =1  
\*DIST=49.762  
\*XF =65.6  
\*YF =-2.051  
\*ZF =6.829  
Z-BUFFER

ELEMENTS

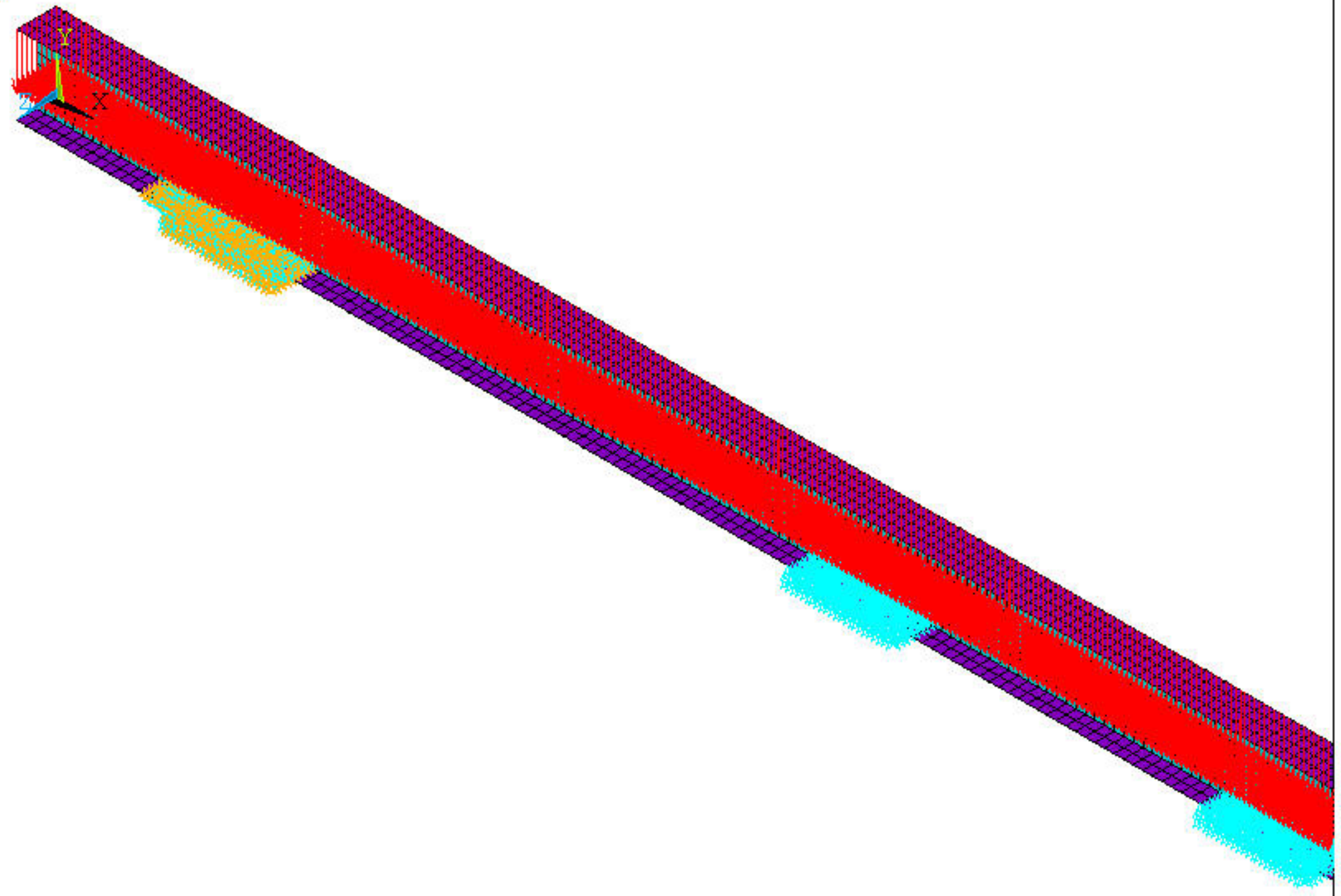
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ROT



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ELEMENTS

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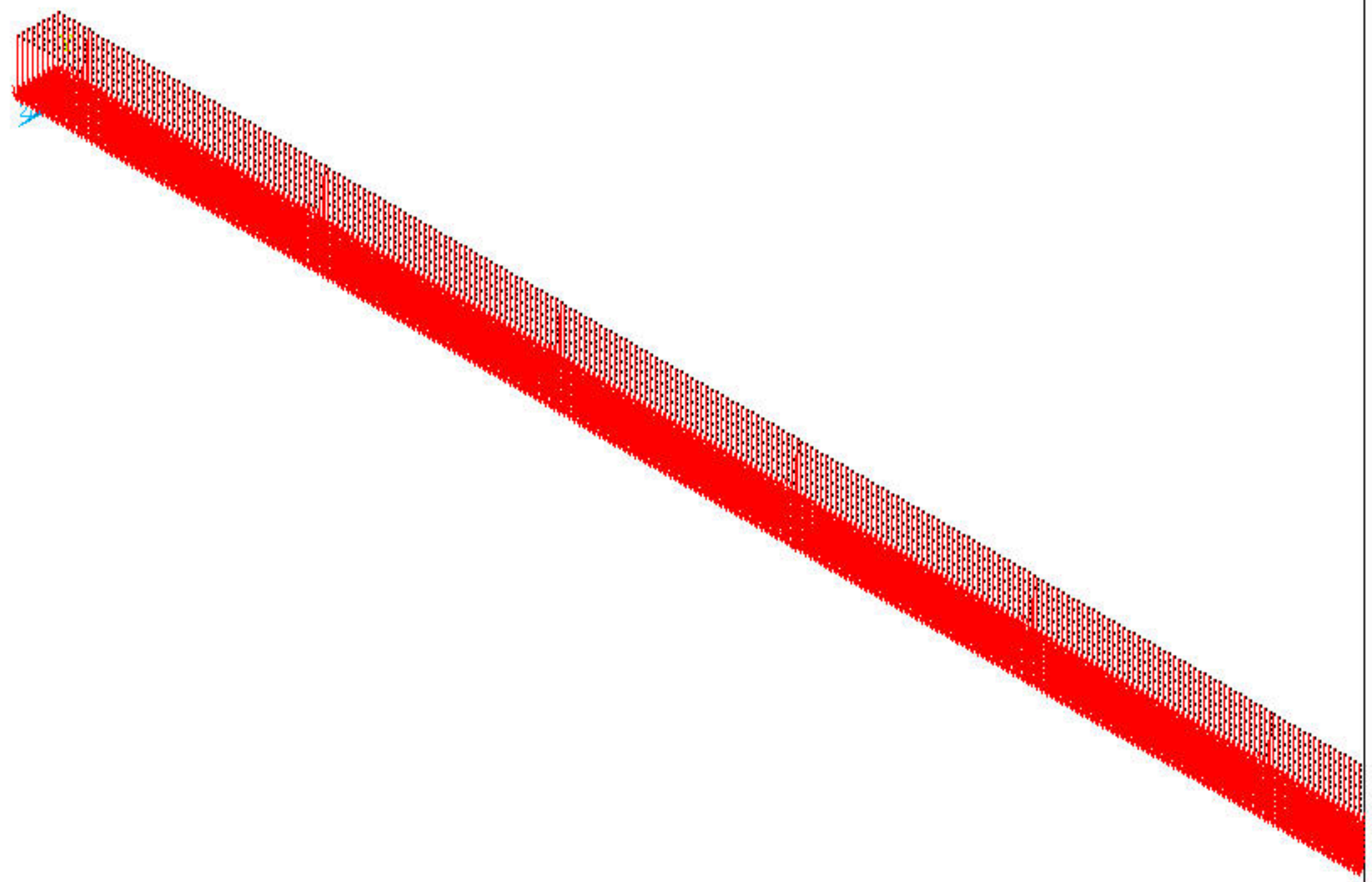




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NODES

F

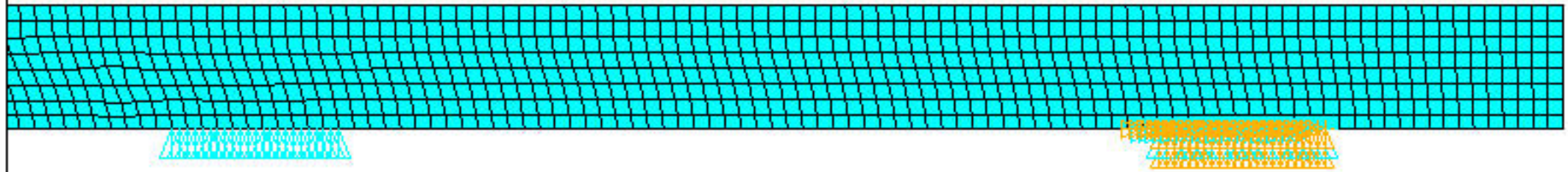


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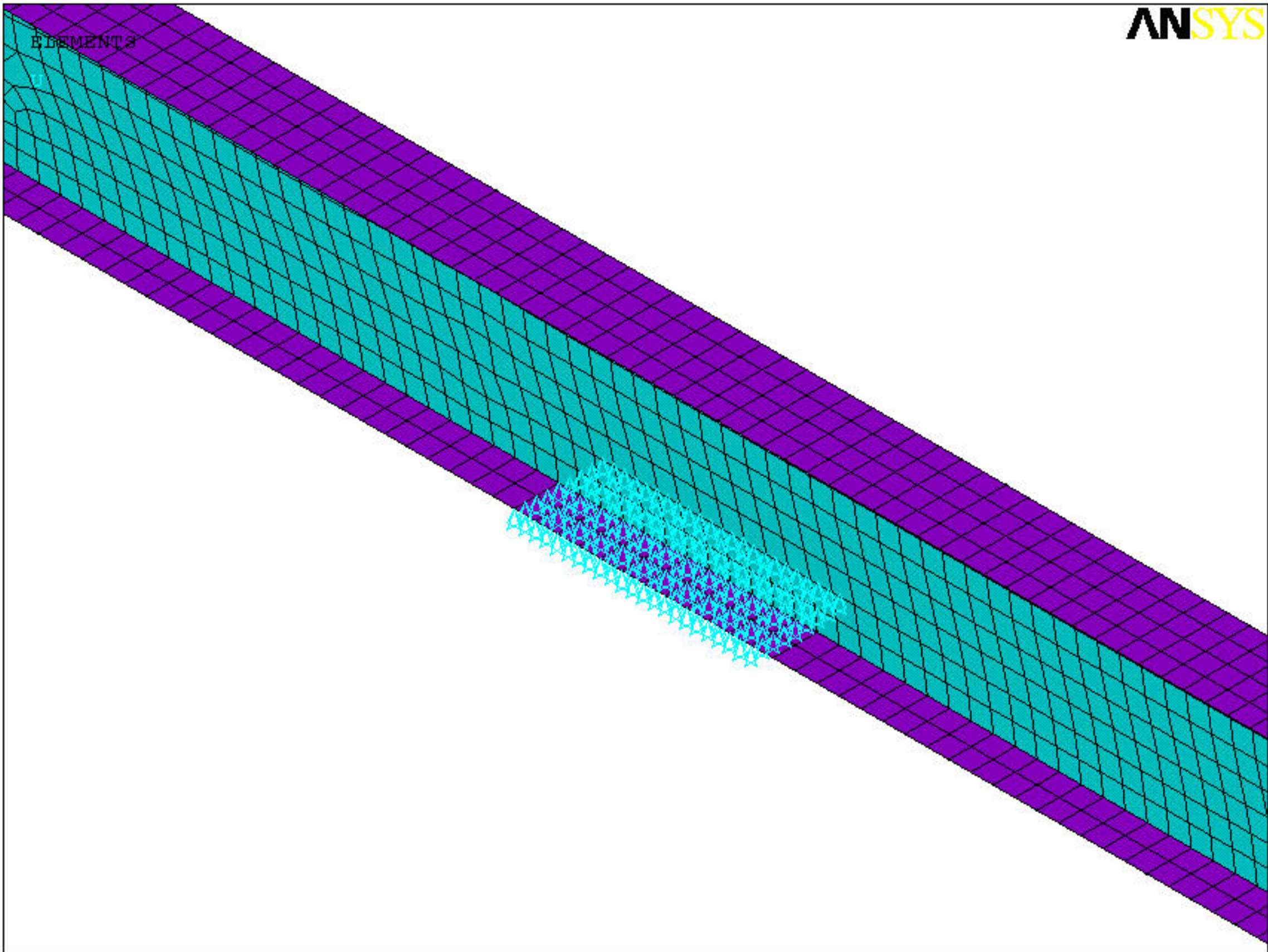
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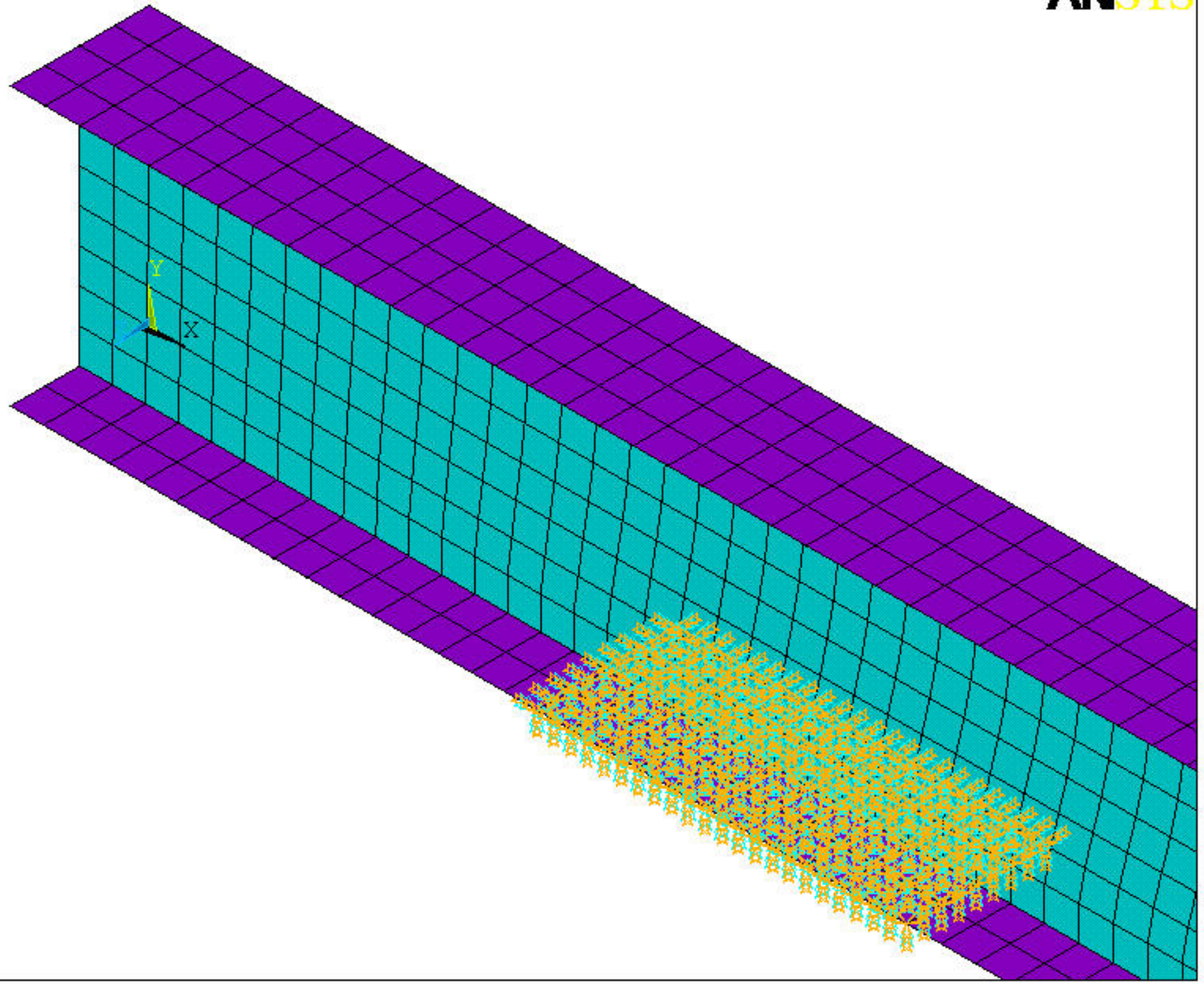


ELEMENTS





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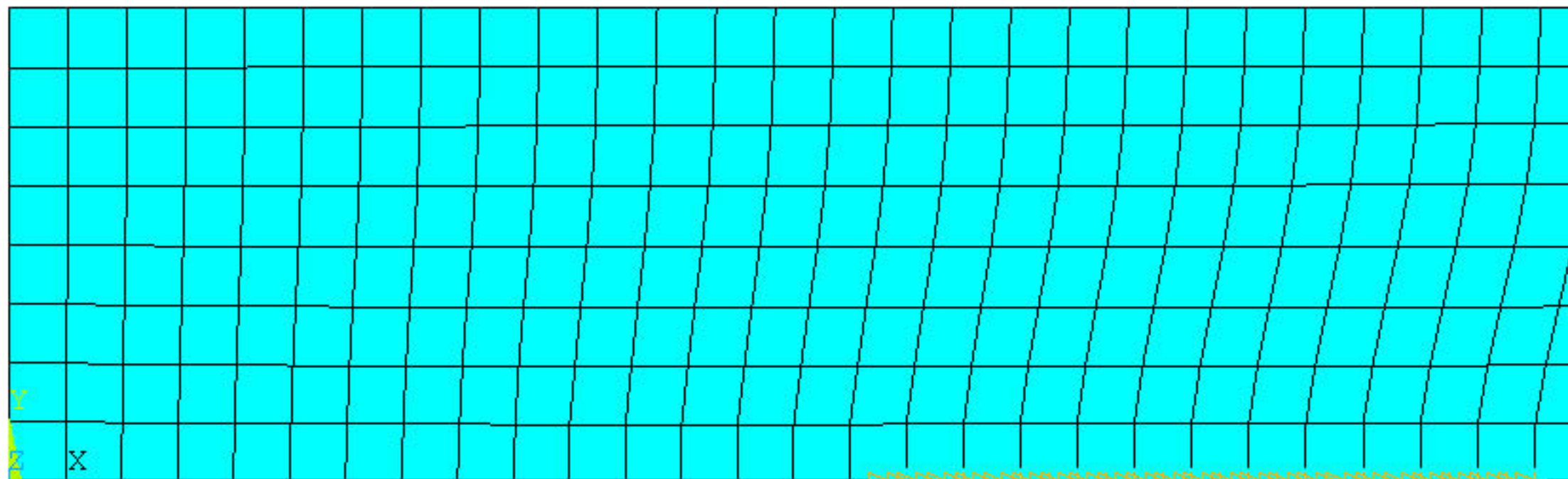


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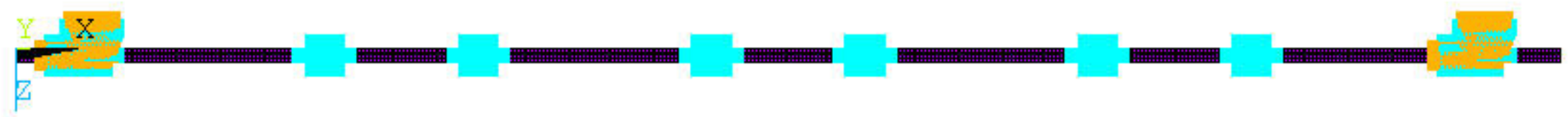


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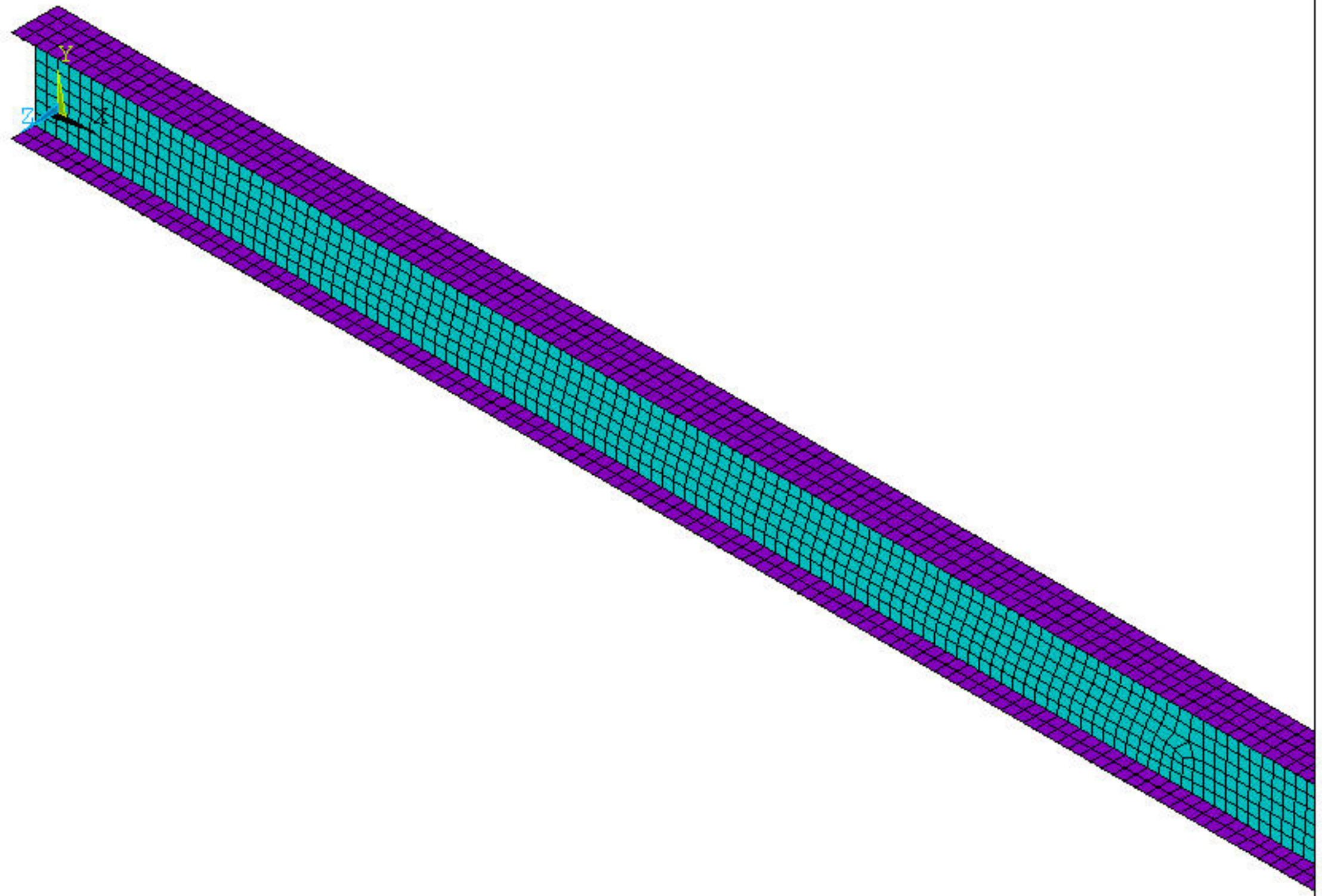
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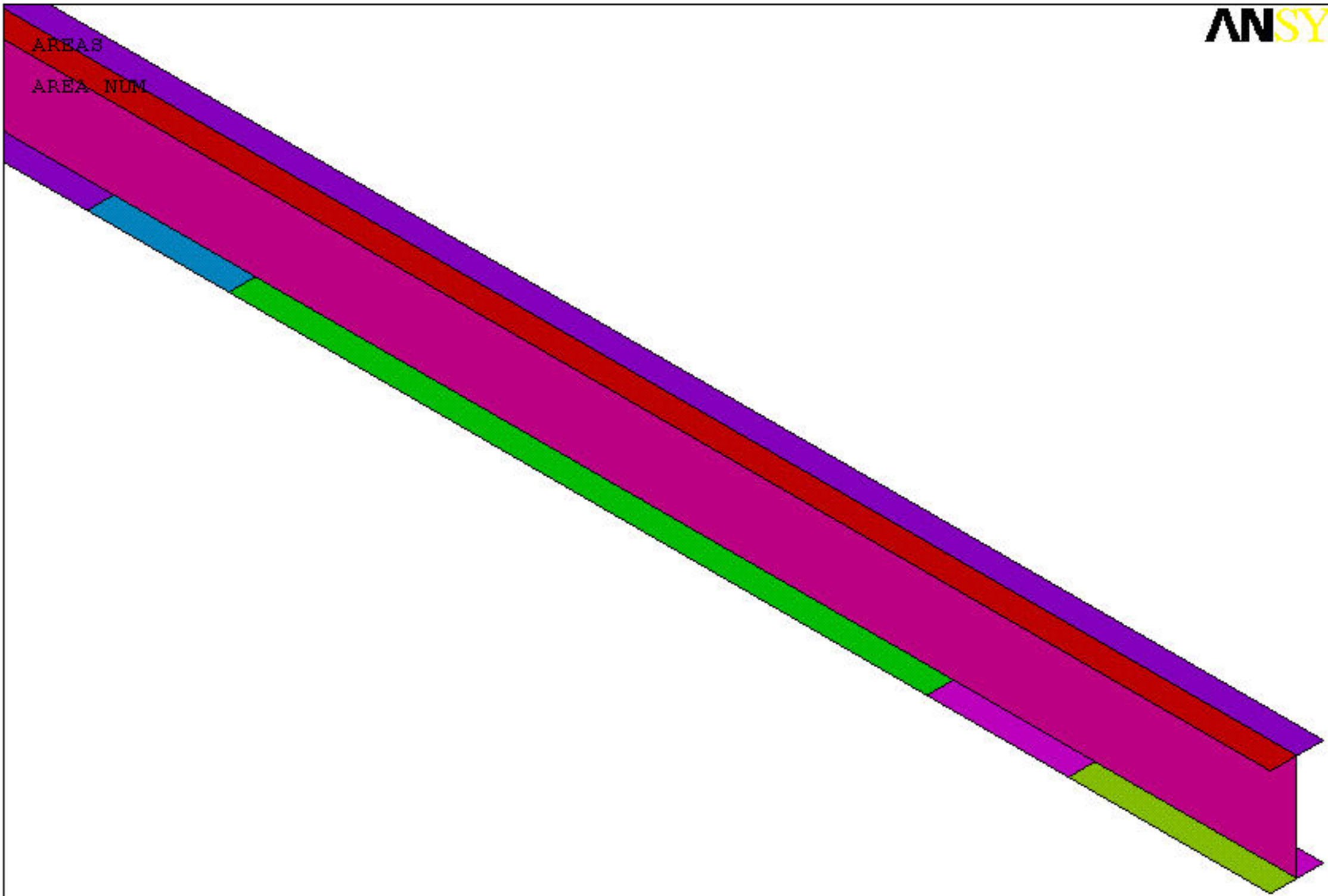


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ELEMENTS



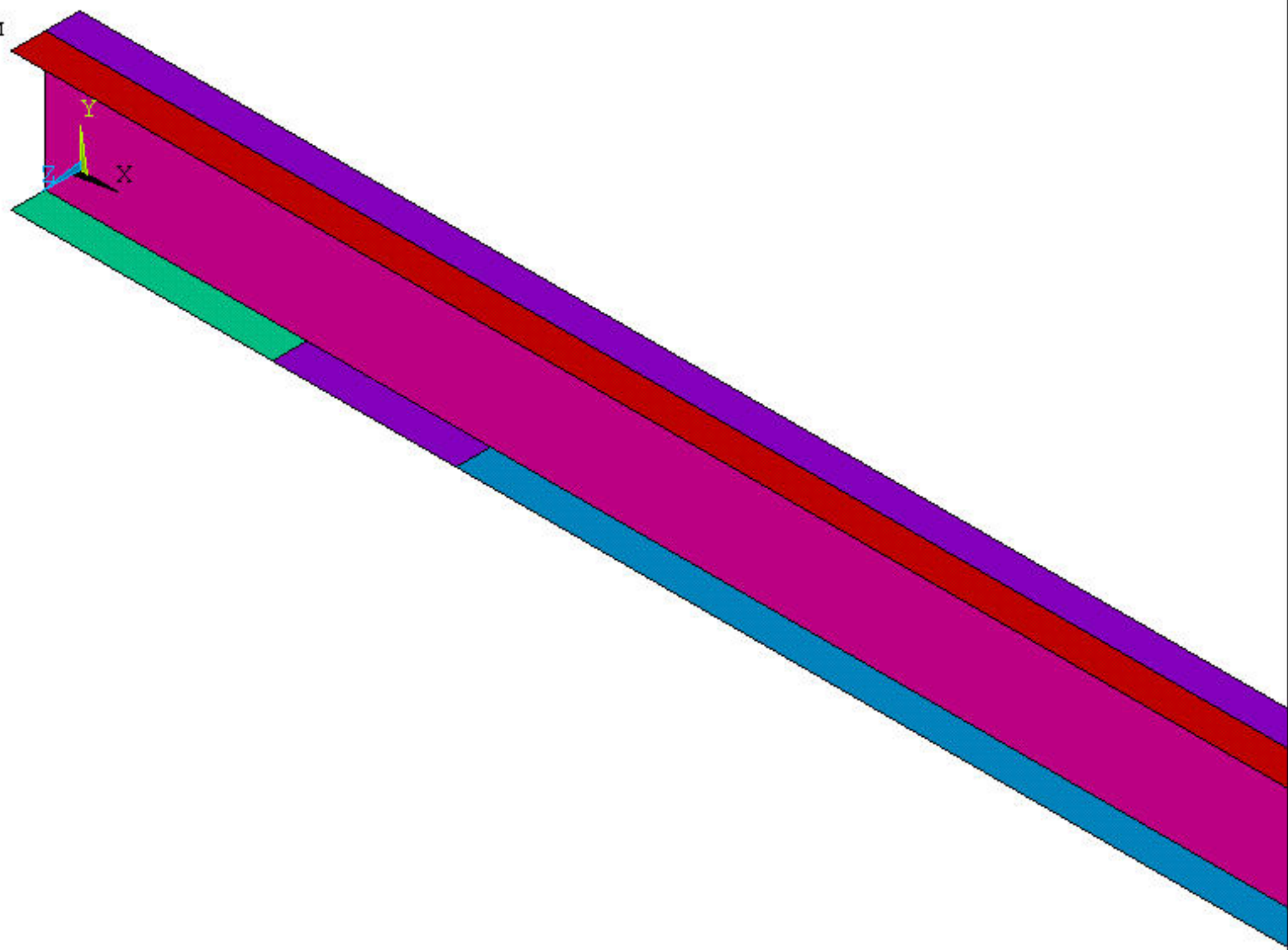
AREAS  
AREA NUM



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AREAS

AREA NUM



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AREAS

AREA NUM

