Can $\nu \neq 0$ be modelled in the finite difference method of plates?
Choose A, B, C or D.

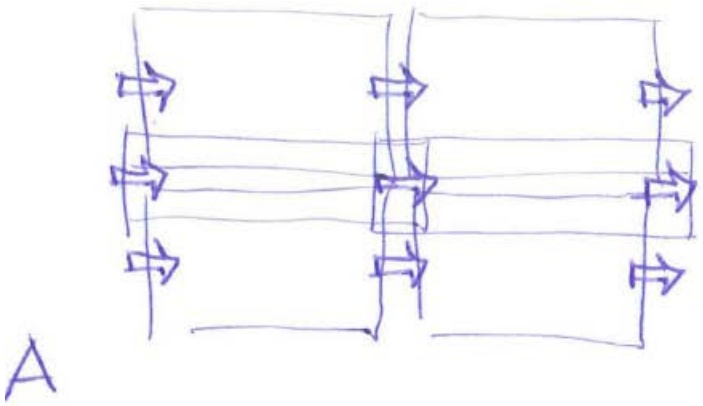
A No, molecules contain information about one material direction only.

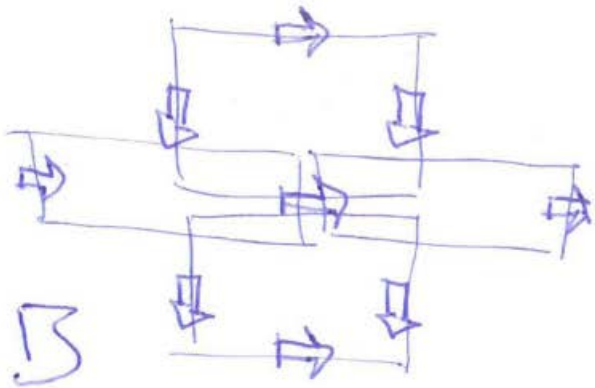
B Not for in-plane load, Yes for perpendicular load.

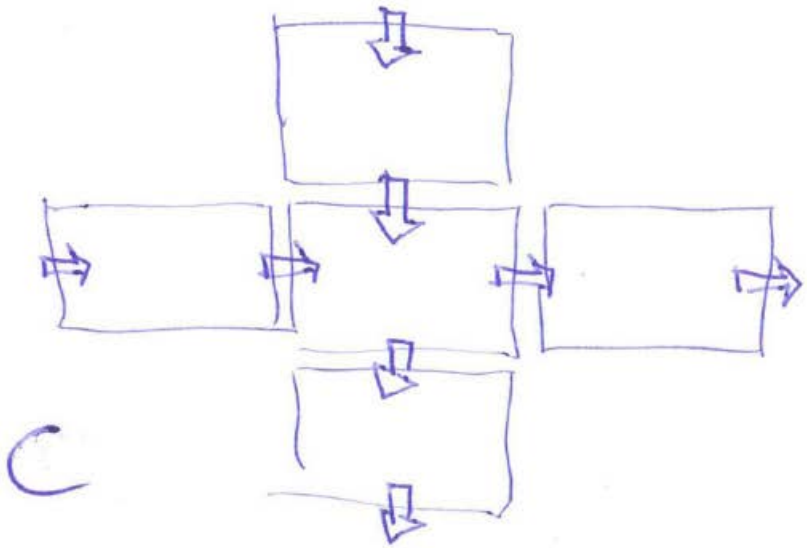
C Yes for in-plane load, Not for perpendicular load.

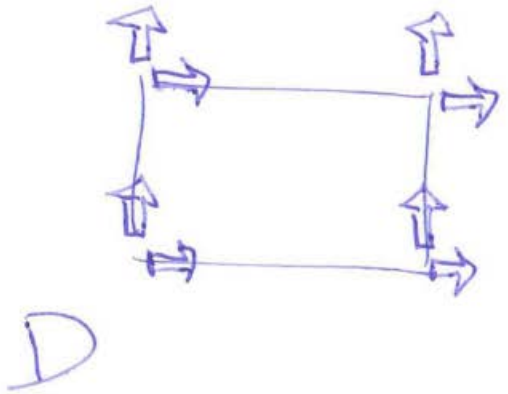
D Yes, any differential equation can be solved with the finite difference method.

Which is the main molecule for plates loaded in plane?
Choose A, B, C or D.









Why is the finite difference method not suitable for plates with circular openings? Choose A, B, C or D.

A Circular openings can have large stress concentrations.

B The shape functions need to have straight edges.

C It is difficult to draw a grid around a circular opening.

D There are no edge molecules for curved edges.

The Kirchhoff theory has a big advantage over the Mindlin-Reissner theory. What is this advantage? Choose A, B, C or D.

A The edge situation is easy to interpret because the torsion moments are zero in plate edges that are supported by hinges.

B The elements do not need to be extremely small for obtaining converged results.

C It is also valid for thick plates and very thick plates.

D It is definitely correct because Kirchhoff was brilliant physicist.

What is “finite” about the finite element method? Choose A, B, C or D.

A The method is finite; it has limitations.

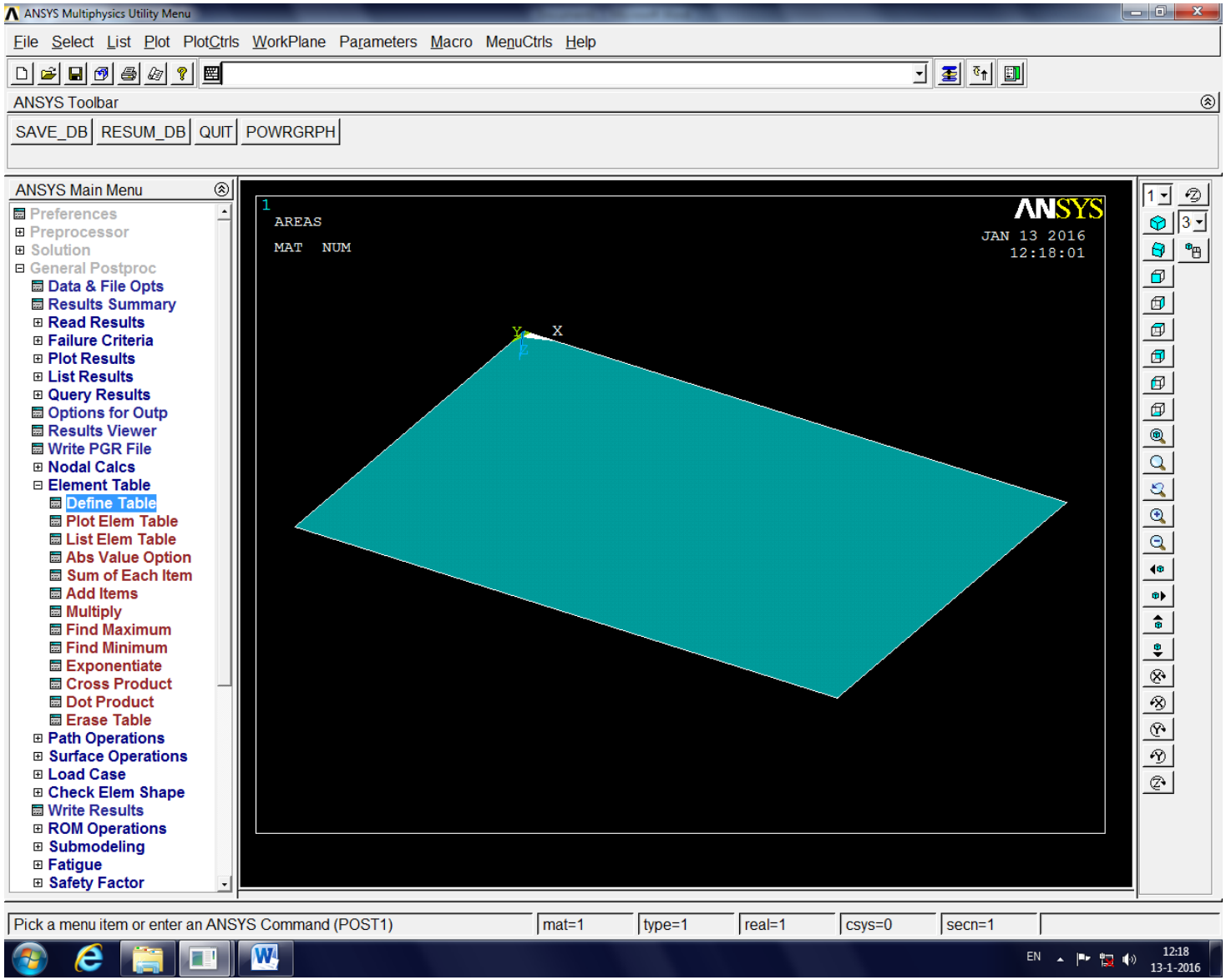
B The elements are finite; they are not infinitely small.

C The number of elements are finite;
we do not use an infinite amount of elements.

D The computed stresses are finite; they cannot be infinitely large.

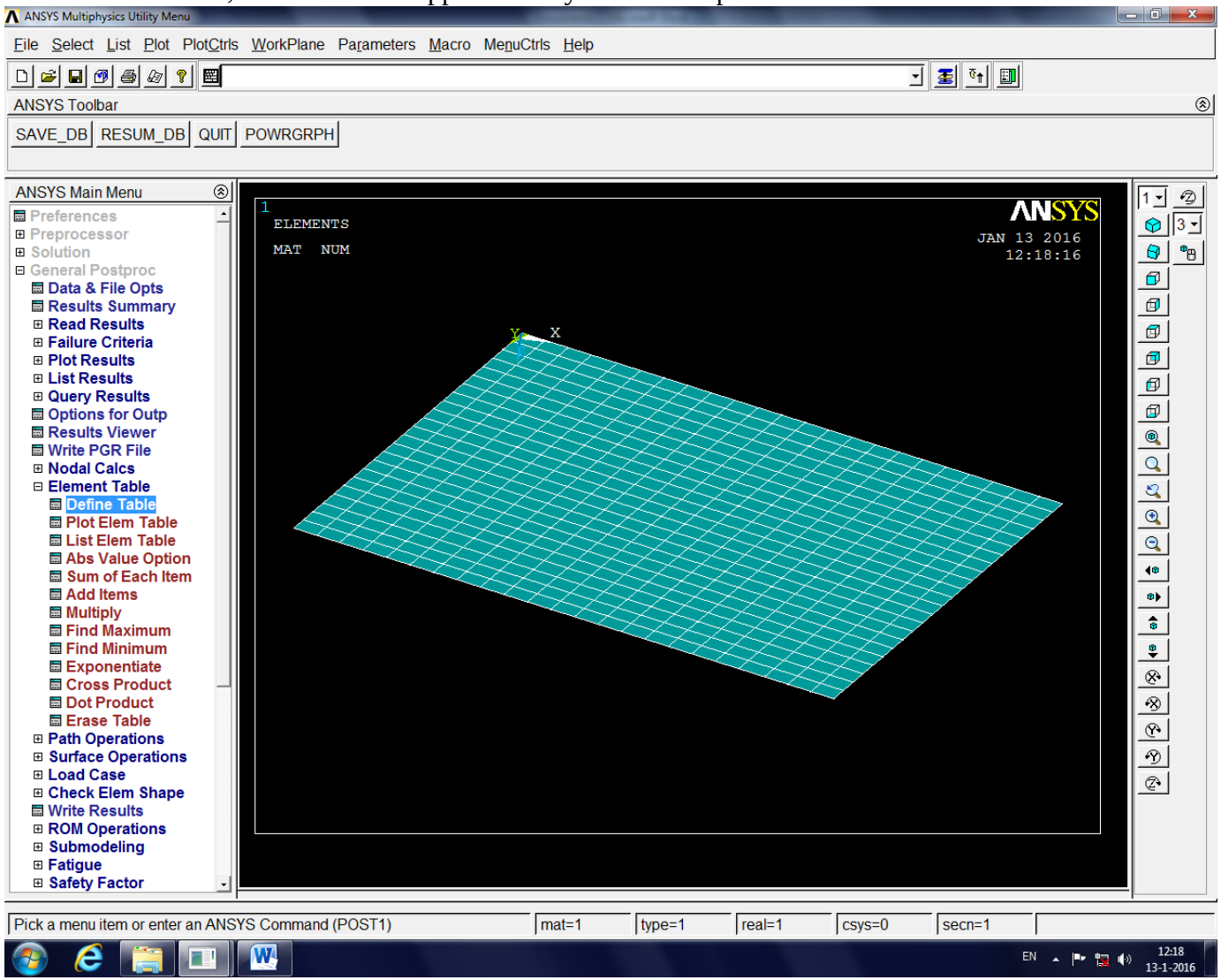
Note: In science, the word “finite” means “not infinitesimal” or “not very very small”.

plate loaded perpendicularly by an evenly distributed load

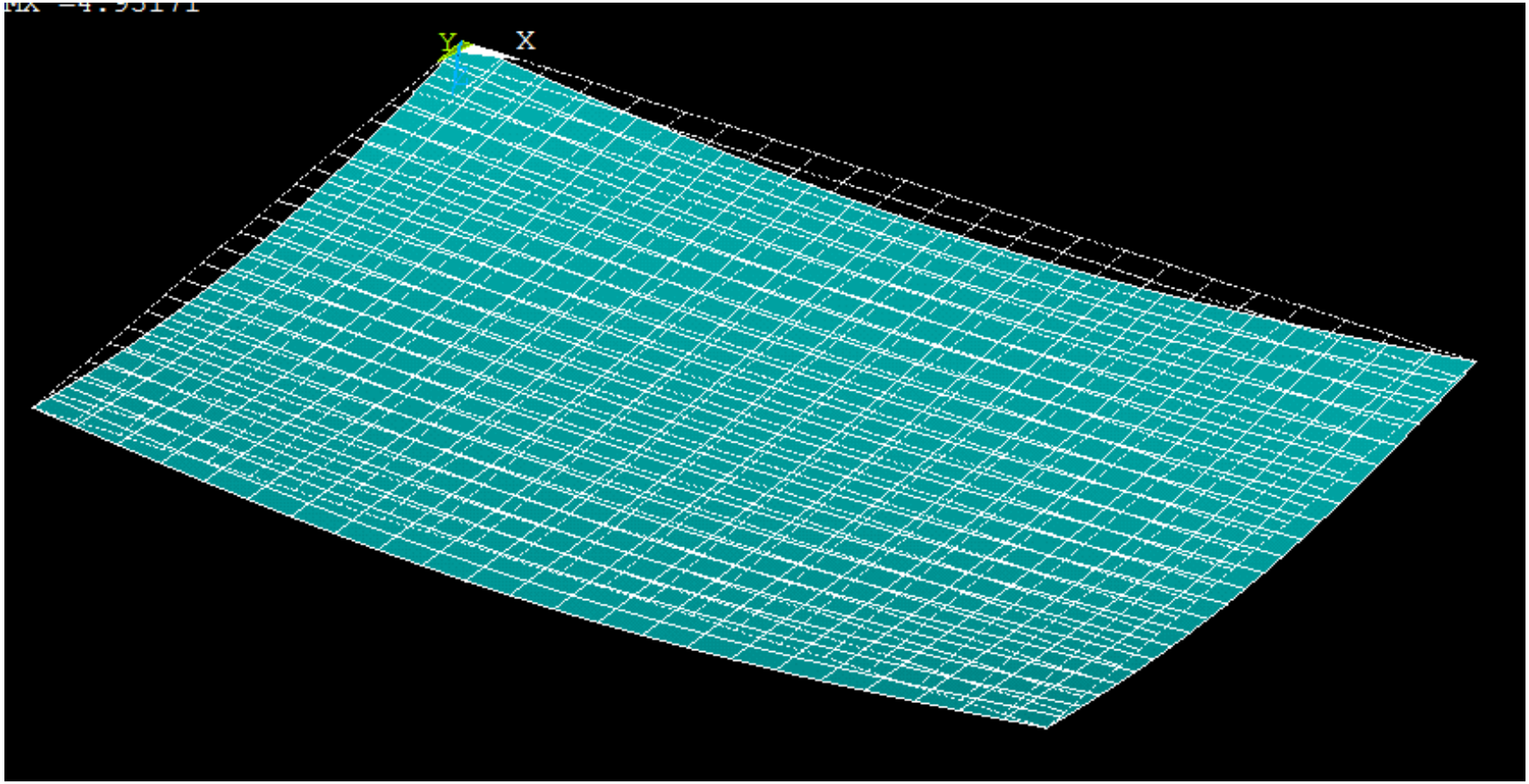


length = width = 1000
thickness = 30
E = 2.1e5
v = 0.3
The support is statically determined, in all corners uz = 0
The distributed load is 0.1 in the positive z direction.
The Mindlin-Reissner theory is used.

finite element mesh, element size is approximately 2 times the plate thickness.

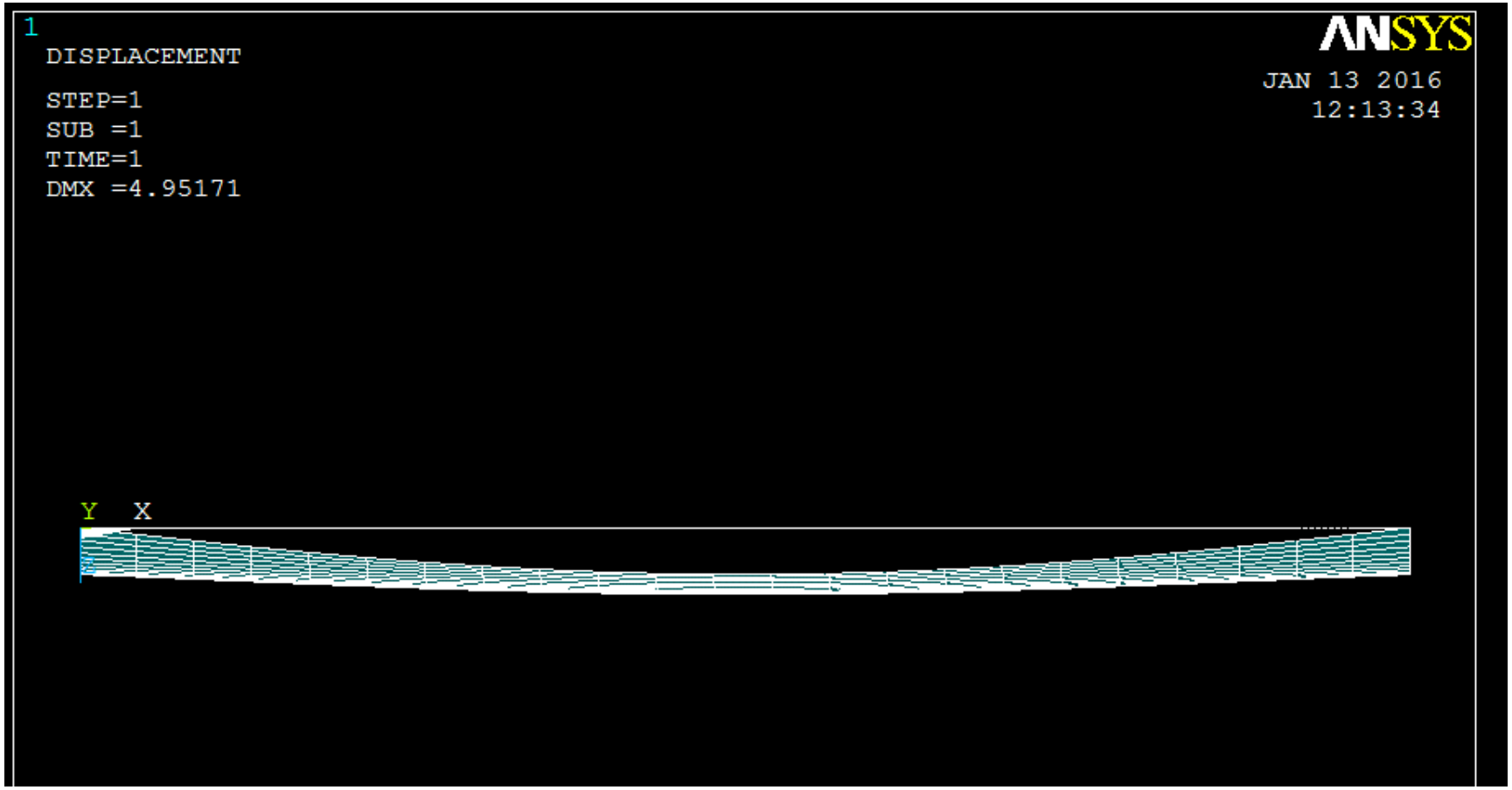


deflection



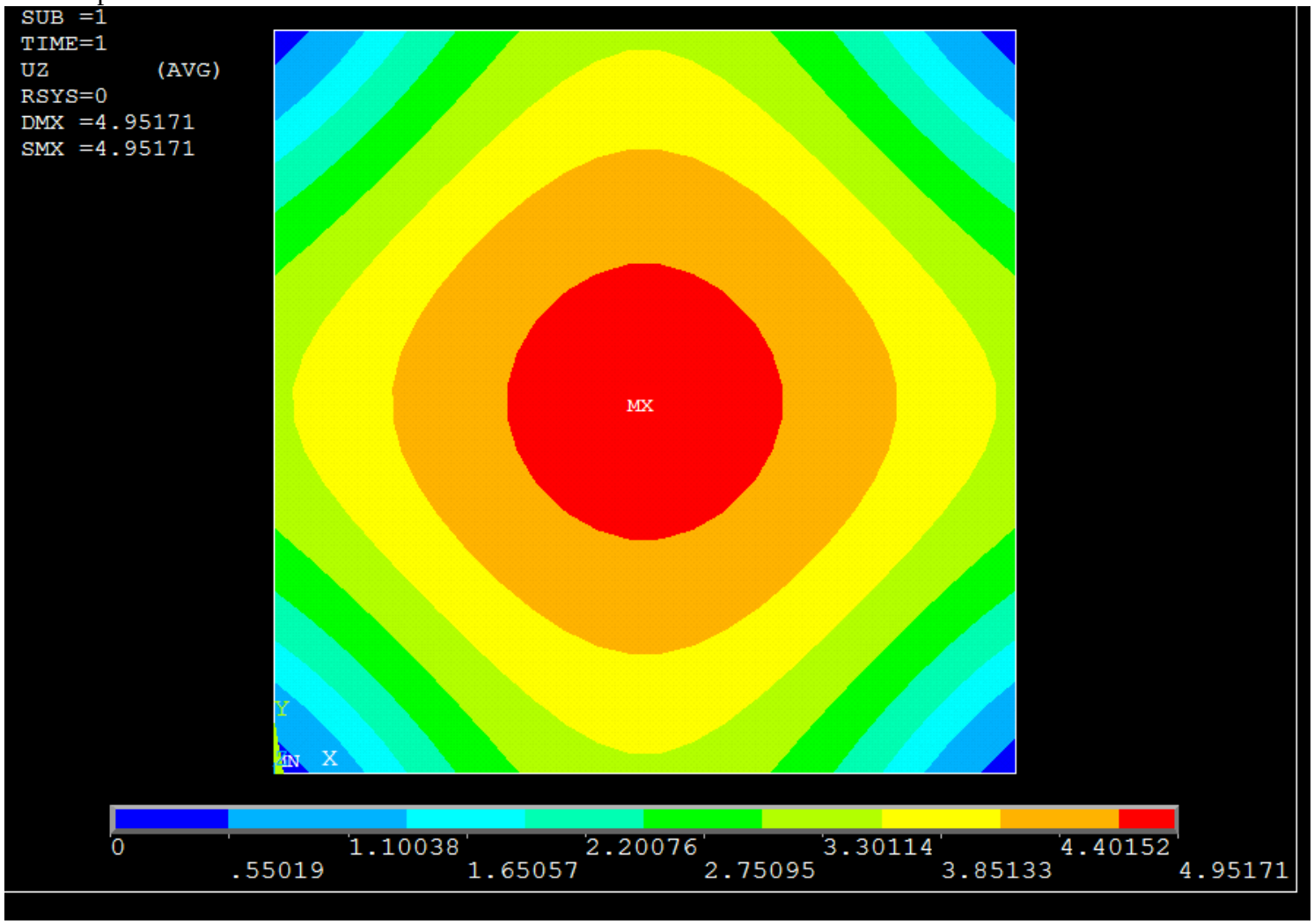
Note that the corners do not deflect. So this was modelled correctly.

deflection



Note that the edges deflect almost as much as the middle.

contour plot of the deflection

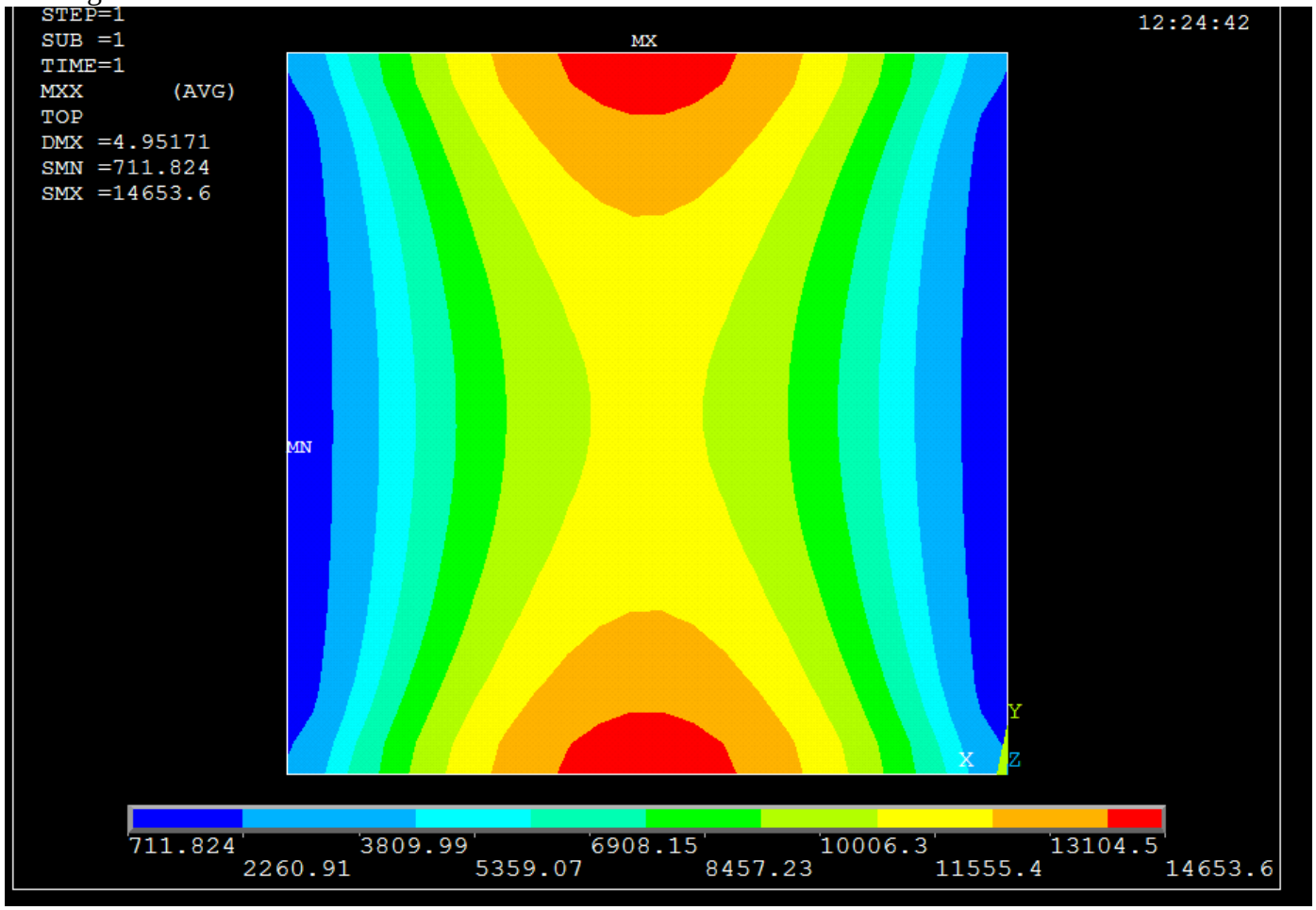


Exam questions can be: How much does this plate deflect? What is the unit of this deflection?

In ANSYS you need to type the following commands to display the moments. Without these commands ANSYS plots stresses only.

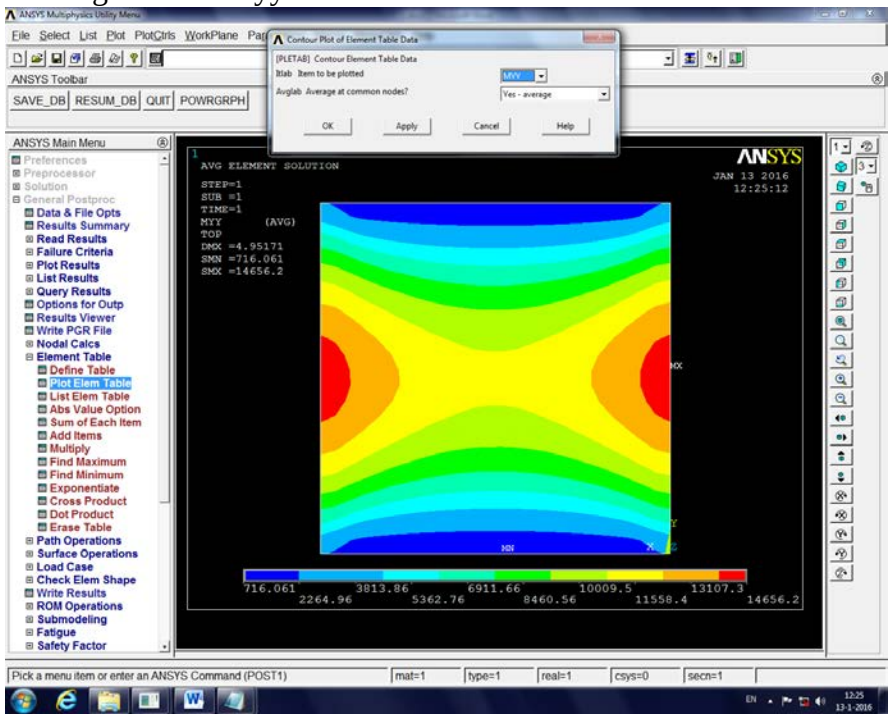
```
ETABLE,nxx,SMISC,1
ETABLE,nyy,SMISC,2
ETABLE,nxy,SMISC,3
ETABLE,mxx,SMISC,4
ETABLE,myy,SMISC,5
ETABLE,mxy,SMISC,6
ETABLE,vx ,SMISC,7
ETABLE,vy ,SMISC,8
```

bending moment mxx



Exam questions can be: What is the largest value of the bending moment mxx? Where does it occur? What is the unit of the value? Are the values averaged in nodes? Why are the moments on the edge x=0 not equal to zero? (The coordinate system can be seen in the bottom right of the plate.)

bending moment myy



It is symmetrical with mxx, which is correct because the geometry, supports and load are also symmetrical.

Note that the edges carry more moment than the middle while the middle deflects more than the edges. There is something strange about this. Is this computed correctly? We can think about it for a long time and perhaps find a good explanation but I think that we just need to trust the finite element result here.

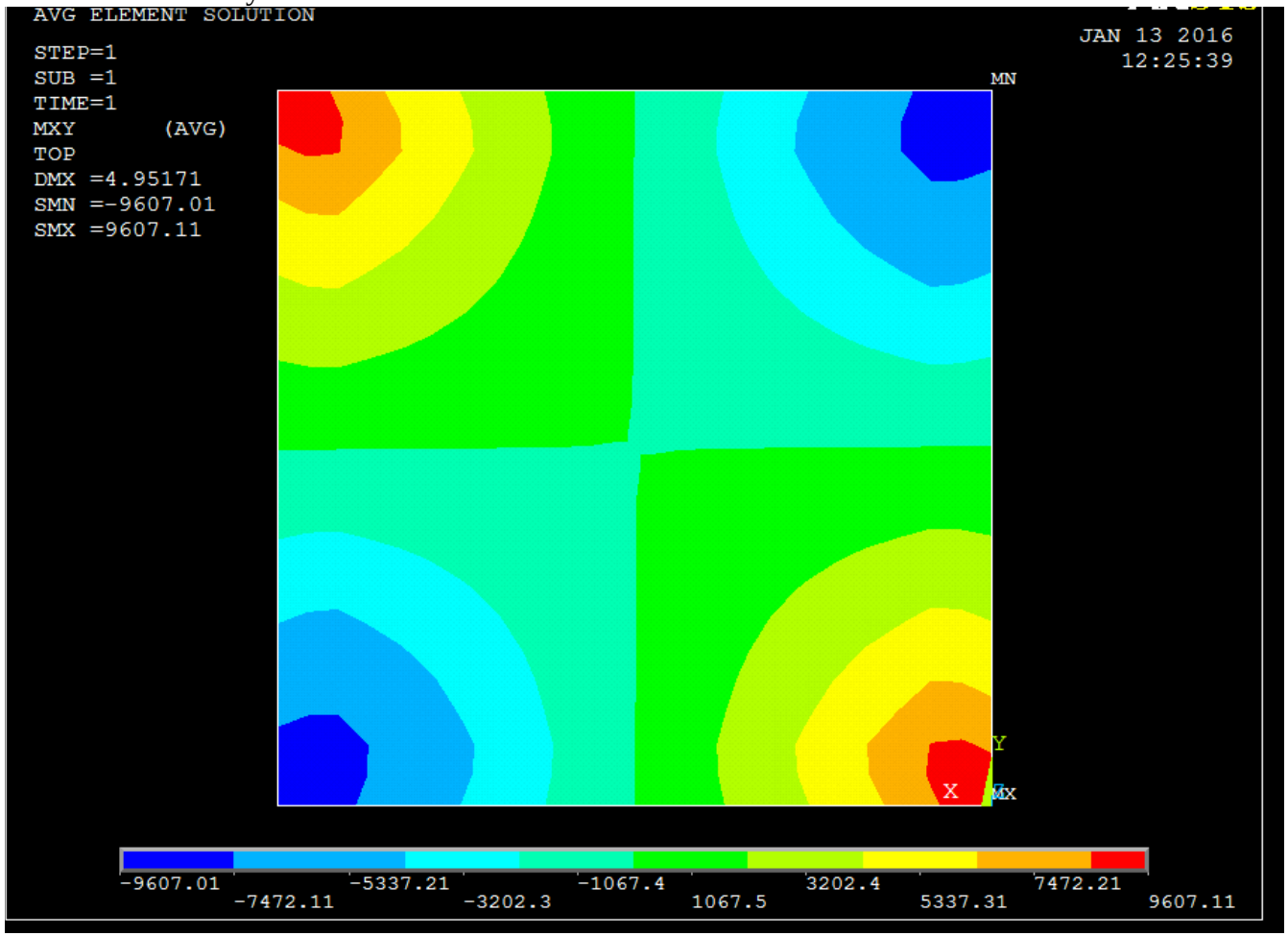
There are two extreme views on finite element analysis:
1) Some engineers believe every computation result and do not check anything.
2) Some engineers think that every finite element result must be checked with a hand calculation.
The first view is just dangerous and the second view is very impractical; often it is simply not possible to calculate the same thing by hand. We need to find a position between those two extreme views.

Ansys has been thoroughly checked against simple structures that we can calculate by hand too. This plate example is not such a simple structure ... for us. A computer does not see a difference between simple structures and difficult structures. If a computer computes all our simple structures perfectly, than it is very likely also to compute our difficult structures perfectly. So, when studying computation results we do not look for mistakes that Ansys has made. We look for mistakes that we have made in modelling the structure, in using the software or in interpreting the results.

If you really think that the software makes a mistake then the best check is to model the same structure in for example Abaqus and compare results. (Abaqus has been written by different programmers than Ansys.)

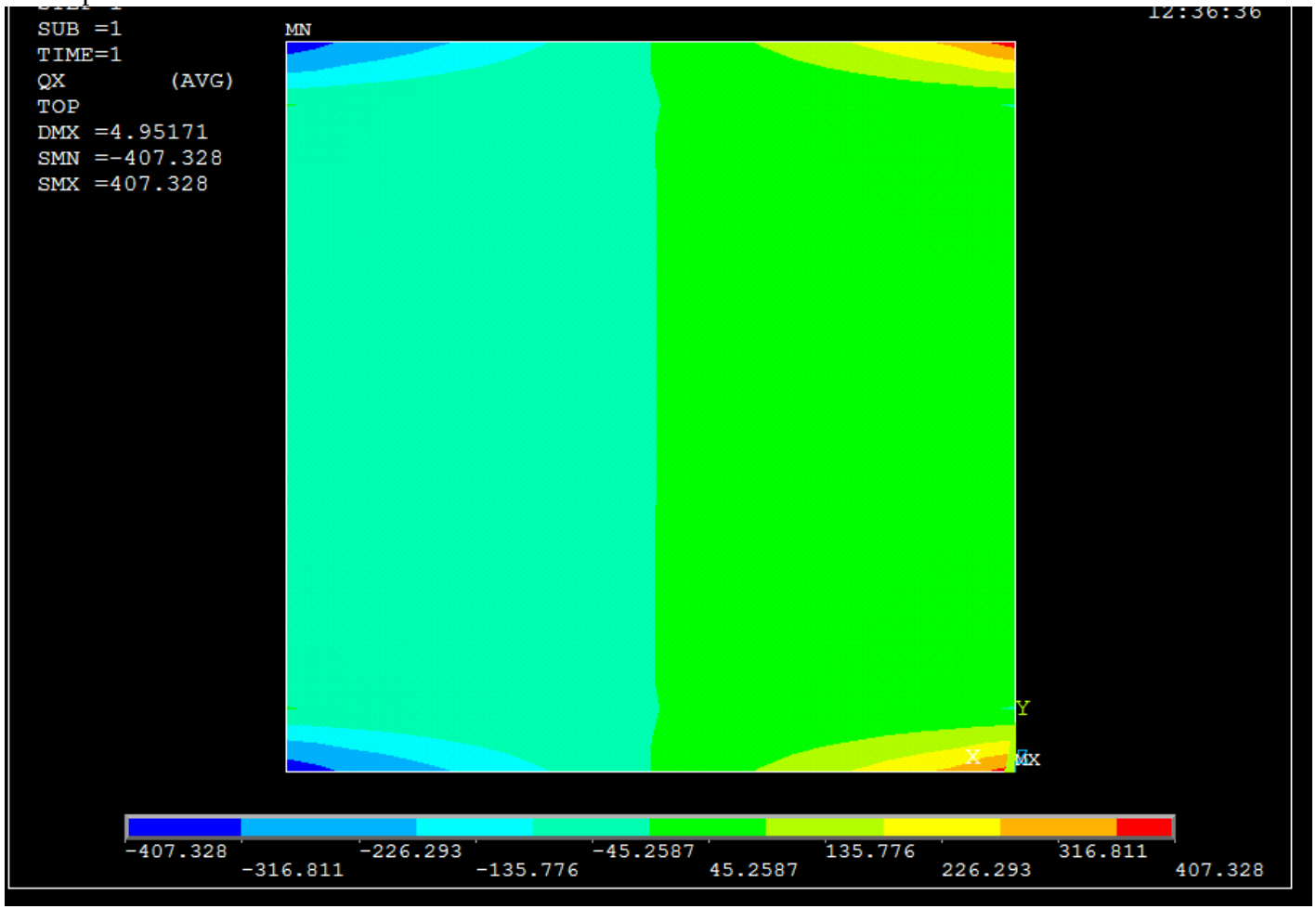
A exam question can be: Does every finite element result need to be checked with a hand calculation?

torsion moment mxy



Exam questions can be: Why is the torsion moment at the edges not equal to zero? What is the largest value of the torsion moment in this plate? The largest moment seems to be 9607 …. but here you need to make comment on the singularities in the corners. (At point loads, point supports and in re-entrant corners the moments are infinite.) Without such comment the answer would be wrong.

out of plane shear force vx



Exam questions: What is the largest value of vx in this plate? (careful) What is the unit of vx? Should vx be equal to zero on the edge x=0? Is the latter in agreement with the analysis result? What is difference between an in plane shear force and an out of plane shear force?