

Fermilab

PPD/MD/Engineering Analysis Group

The Effect of Friction Force for a 40 Planes Block (TASD geometry)_1

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As requested, a 40 planes FEA model is created with a contact element at the bottom of the block to simulate the frictional contact behavior as shown in Figure 1. Three cases have been studied as following:

Case 1: The first 4 planes are loaded with a full gravity (PVC + oil) and 21 psi for the 1st & 3rd vertical extrusions only. The remaining 36 planes are non-filled with PVC weight only. The one side of first plane is restrained from moving in the beam direction. Assuming zero friction for first 4 planes with a 0.3 frictional coefficient for the rest of 36 non-filled planes, the calculation shows that the displacement at the bottom of the structure starts with a zero where the restrains are placed and then goes up to ~ 3 mils. Finally, it goes down to zero again after 10-12 planes (~20") as shown in Figure 2. The frictional force generated by 10 -12 non-filled planes are probably big enough to prevent the sliding occurred. In fact, the weight of 10~12 no-filled planes is equivalent to two fully filled planes ($15\% * 12 \text{ planes} = 2$).

Case 2: It is same as Case 1, except to set all frictional coefficient to zero __no friction at bottom with first 4 planes loaded. The Figure 2 shows that the displacement starts with 0 and then increased to ~6 mils where the 4th planes are. It stays there up to the end of block since there is no friction to stop the translation as expected.

Case 3: Instead of only filled with first 4 planes as Case 1 & 2, Case 3 is to study with 40 completely filled planes with a 0.3 frictional coefficient cross the bottom. The calculation result indicates that it is very much lock-up by its own friction as shown in Figure 2. The maximum stress is about 1,000 psi.

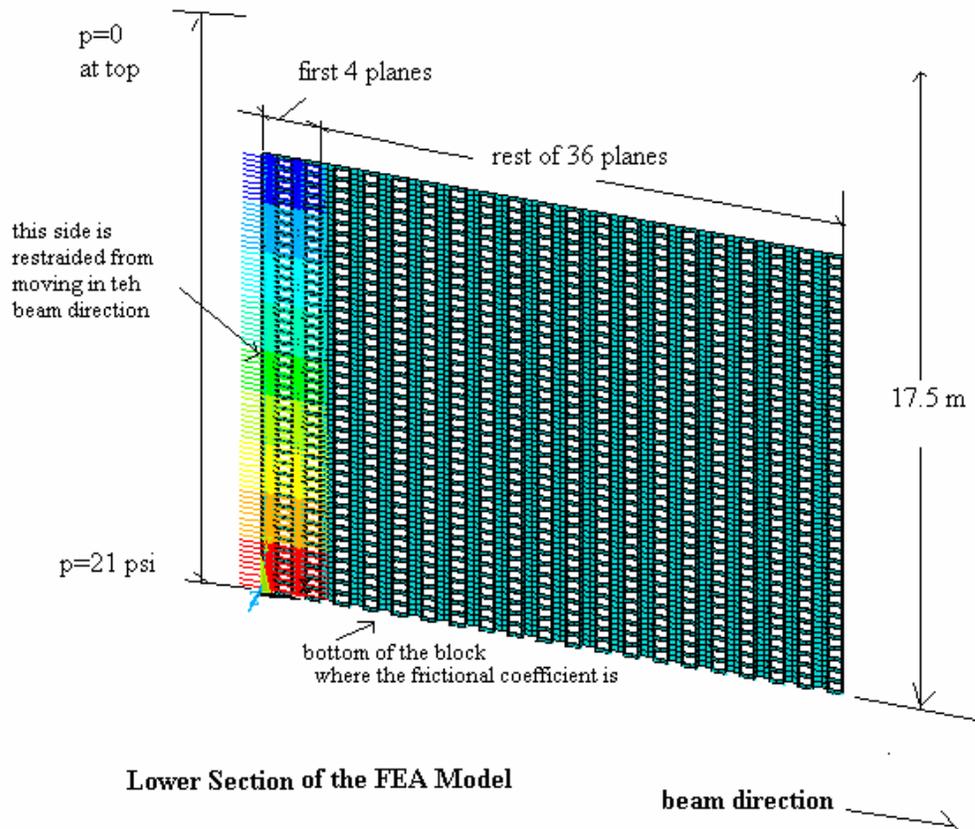


Figure 1 The lower section of the FEA model (17.5 m x 1.8 m)

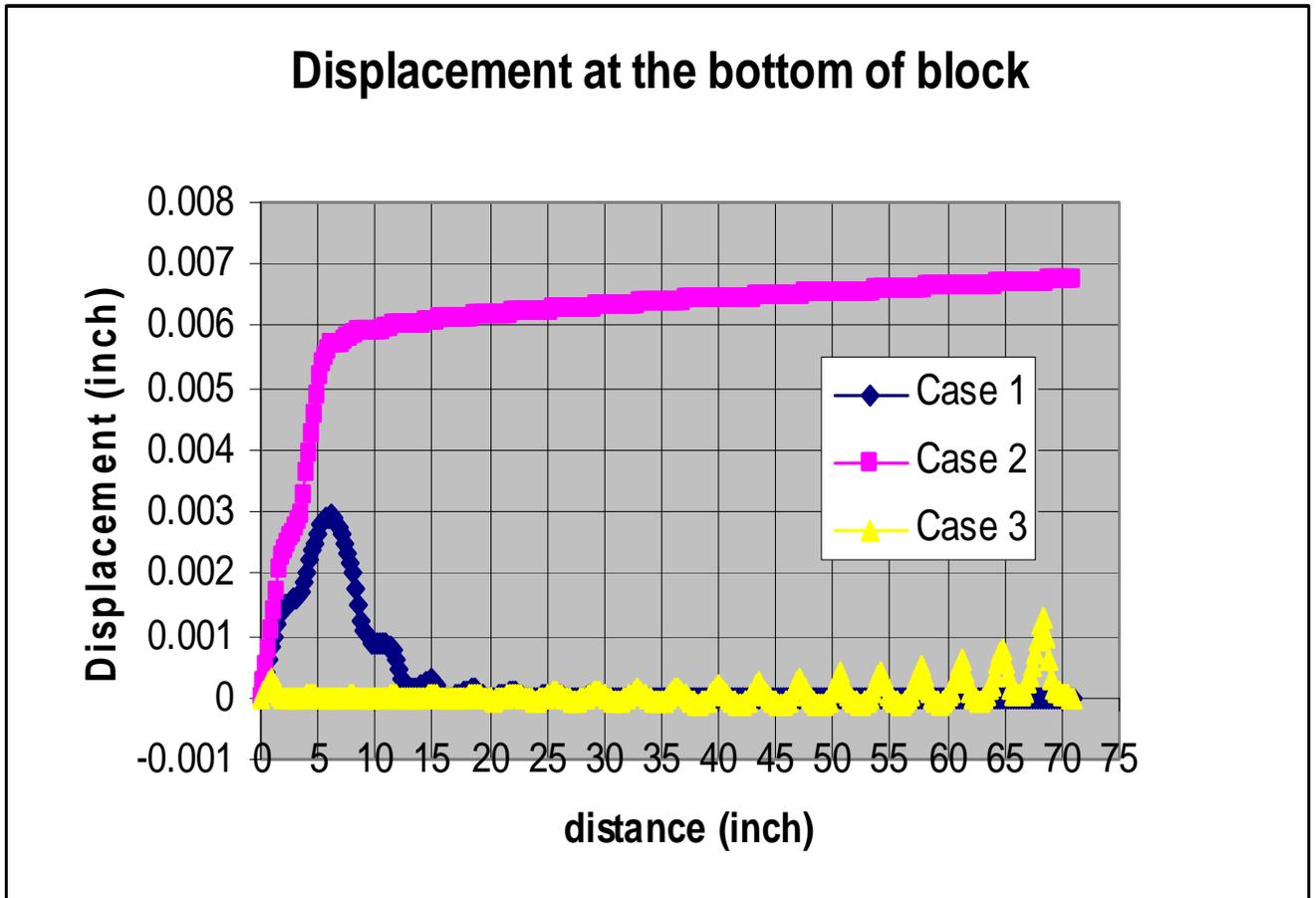


Figure 2 The displacement at the bottom of the block (40 planes) for Case 1, 2 and 3

Case 1: First 4 planes are filled with zero friction and rest of them are non-filled with frictional coefficient =0.3.

Case 2: First 4 planes are filled with zero friction cross the bottom.

Case 3: All 40 planes are filled with a frictional coefficient=0.3 cross the bottom

Appendix:

Several Ansys plots are attached for a further interest.

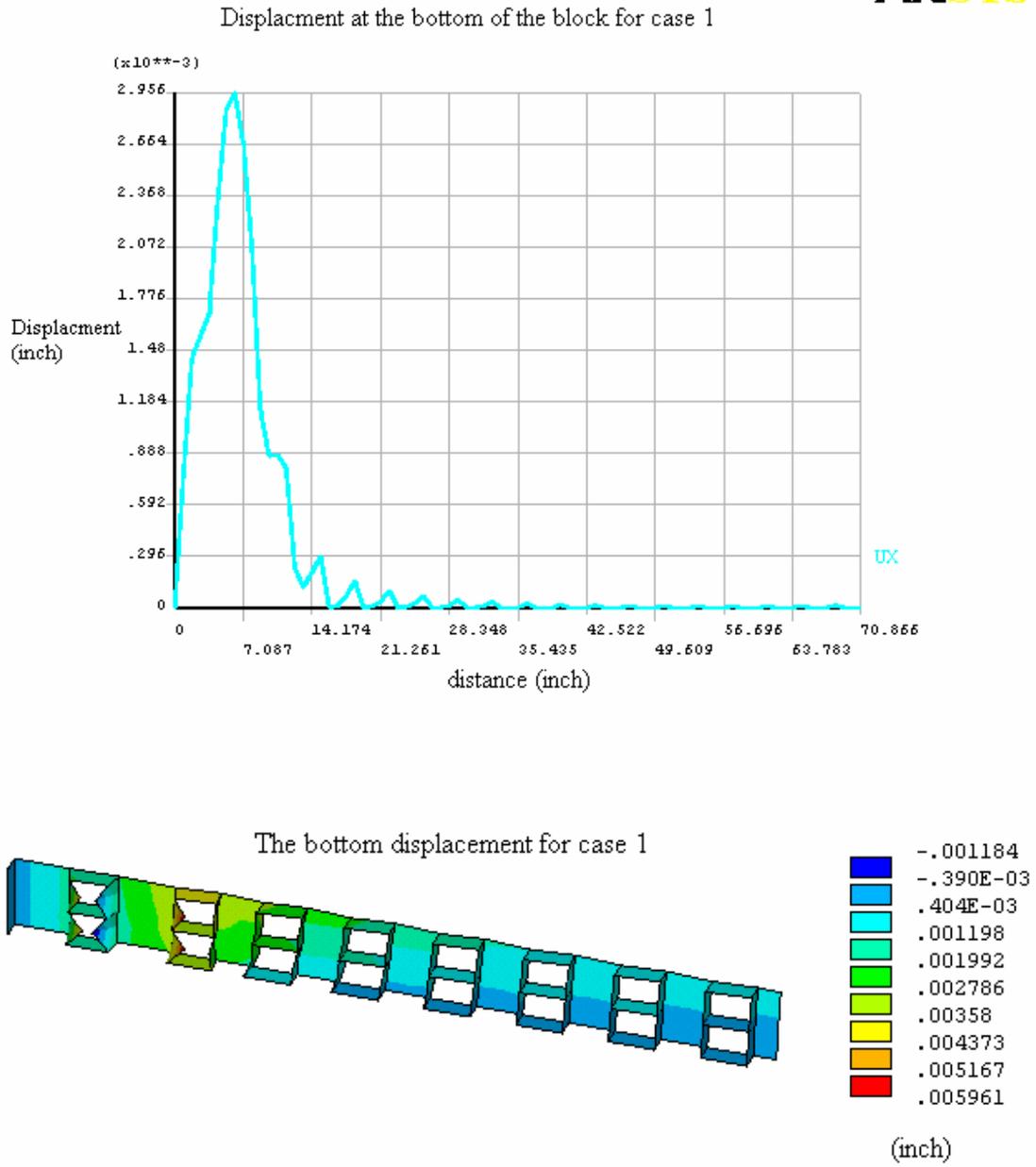


Figure 3 The displacement at the bottom of the block for Case 1

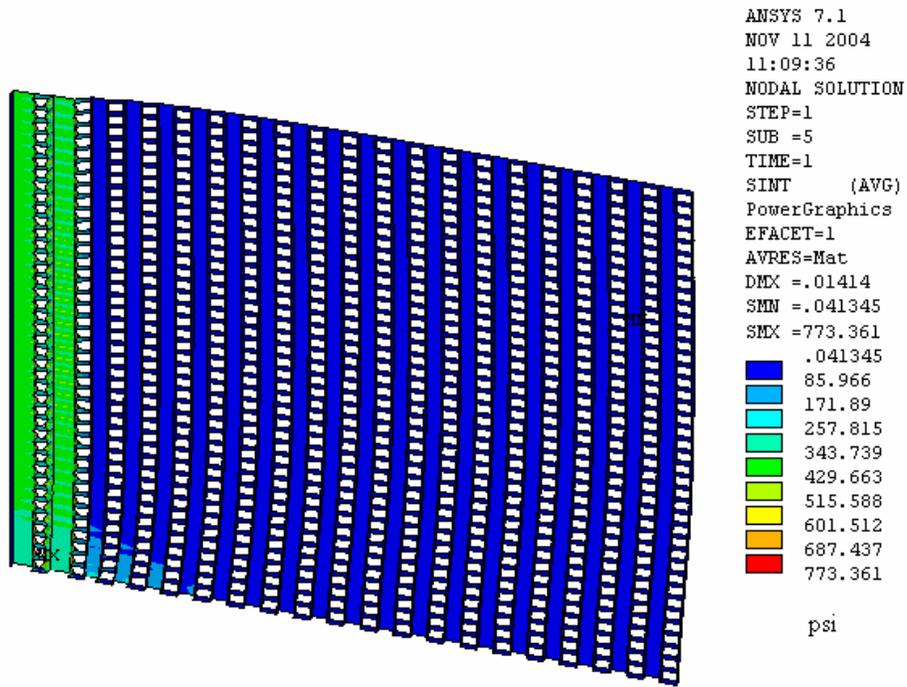
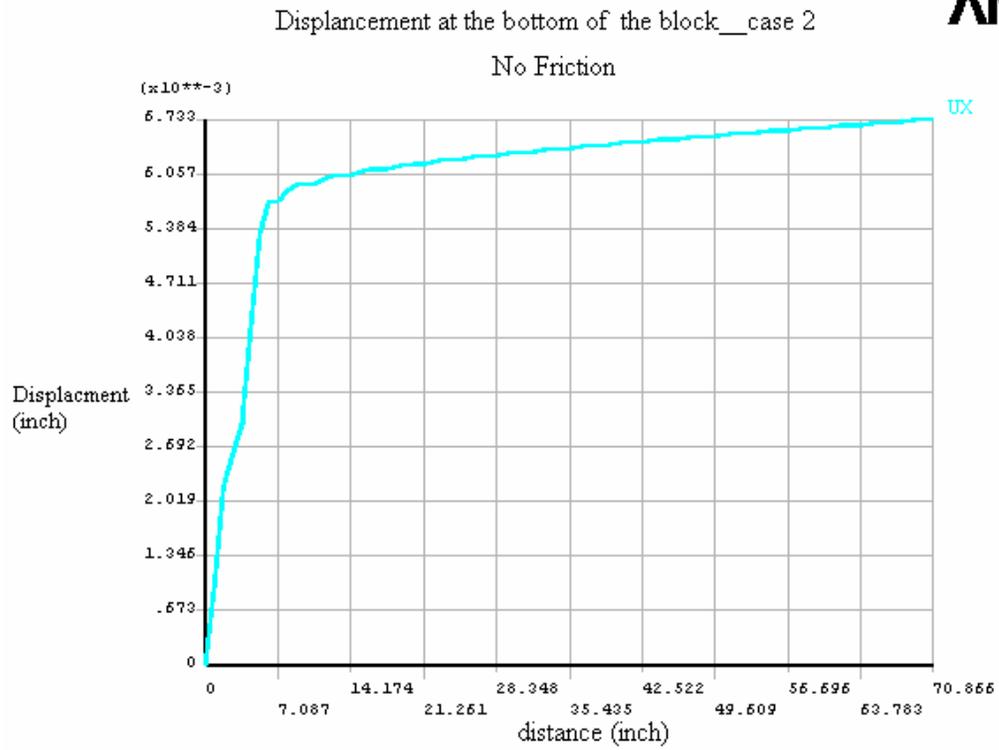


Figure 4 The stress for the case 1



no friction mu=0

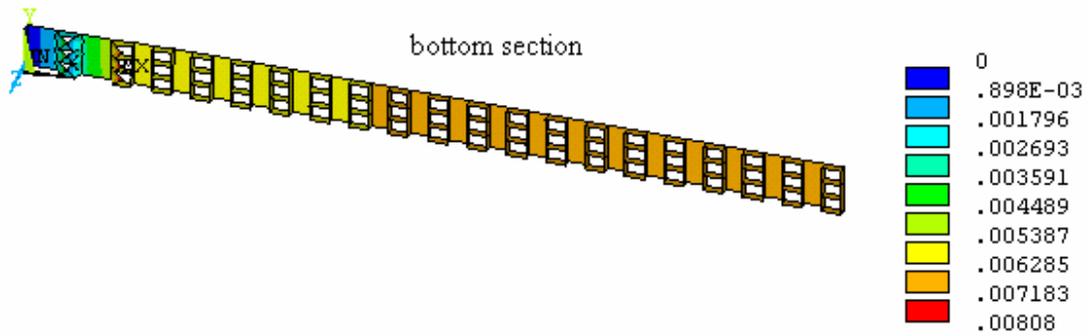


Figure 5 The displacement at the bottom of the block for Case 2

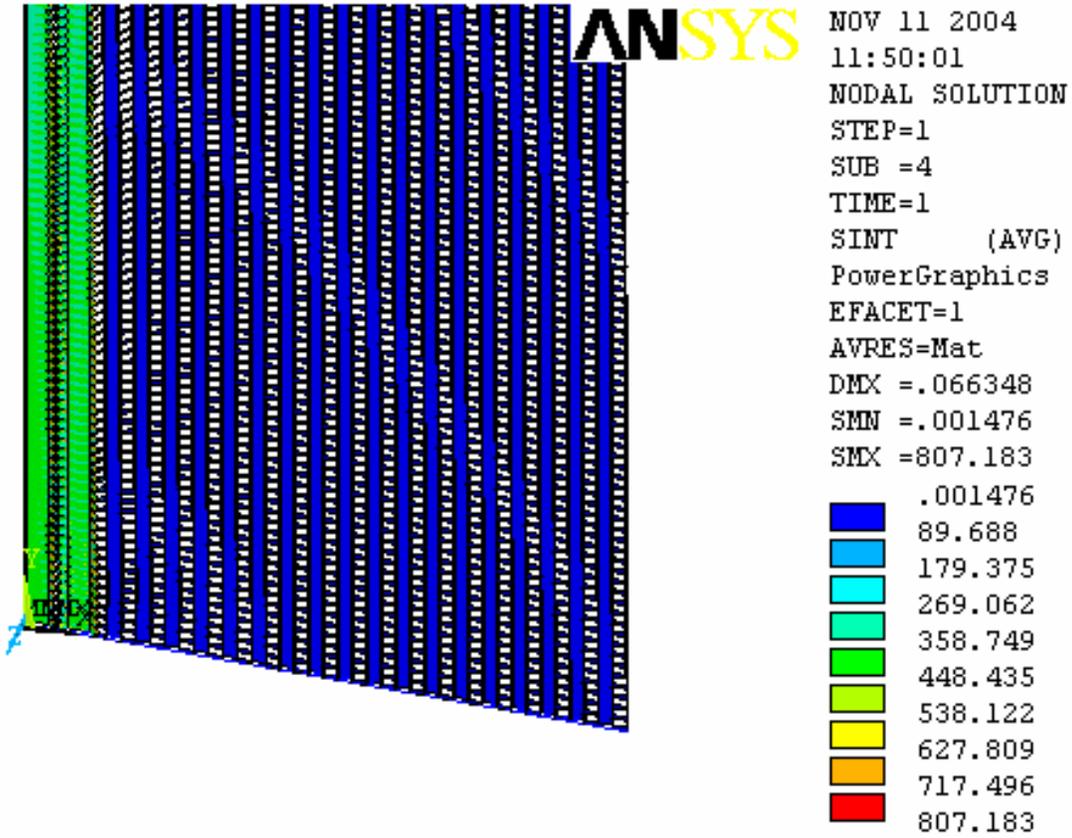


Figure 4 The stress for the case 2

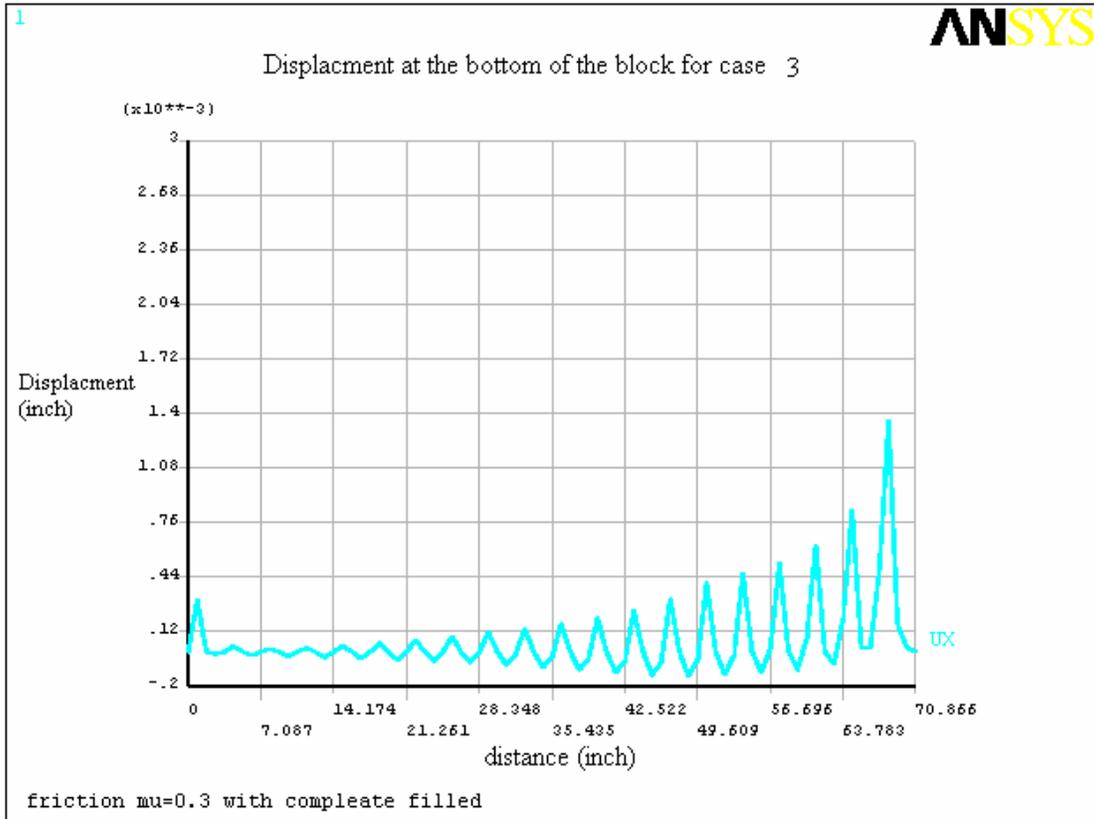
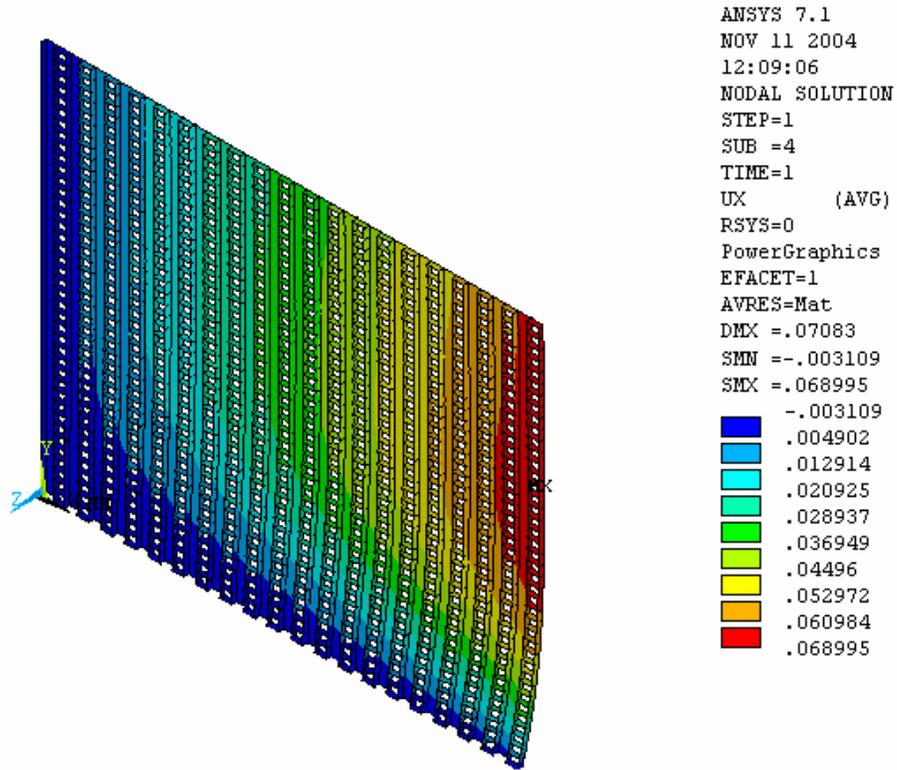


Figure 5 The displacement at the bottom of the block for case 3



friction mu=0.3 with compleate filled

Figure 6 The displacement in the beam direction for case 3

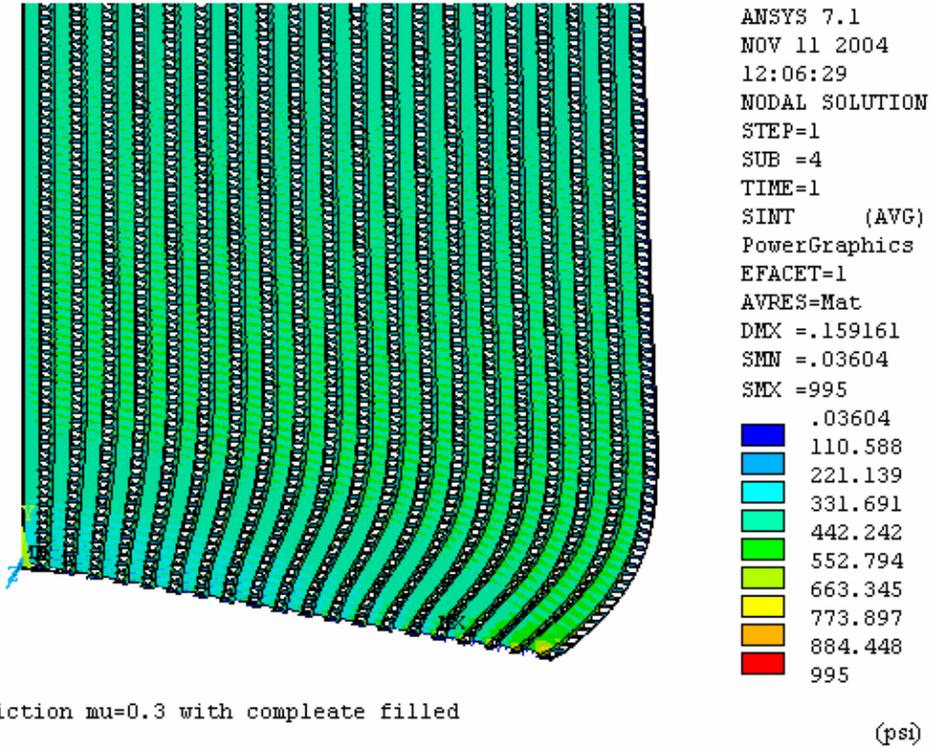
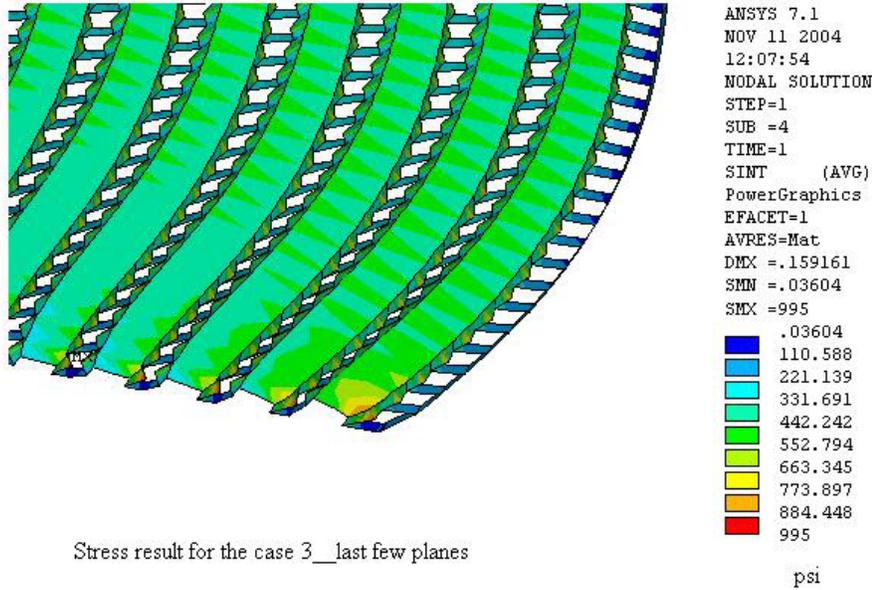
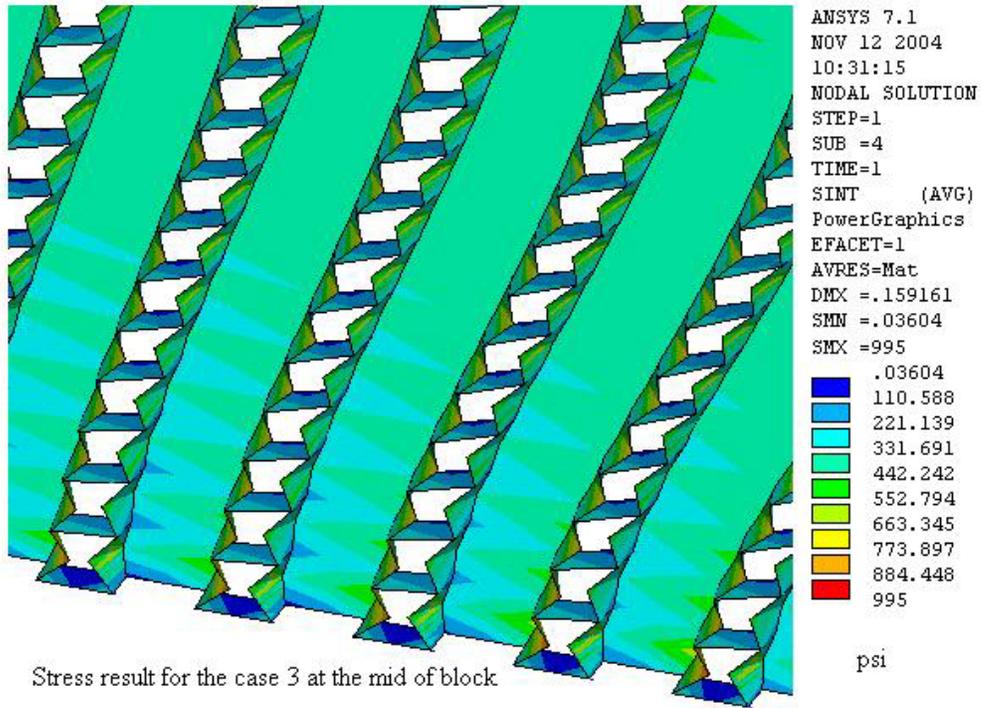


Figure 7 The stress for case 3



friction mu=0.3 with complete filled

Figure 8 The details of the stress for case 3 at the end



friction mu=0.3 with compleate filled

Figure 9 The stress result for case 3 at the mid of block