Type-B SAS external structure initial draft from Fabrizio Raffaelli

The external structure of type-B SAS is a scaffolding made with 4 L profile legs protruding down from a welded steel miniskirt. The miniskirt supports the hydraulic platform and may be welded to it for additional stiffness.
The feet of the legs are tied by stiffening plates, and mount on the magnetic clamps, via large diameter and short leveling screws.
The initial structure shown in figure 1 showed a deflection of 0.9 mm with a 4 ton head load, and low resonant frequencies.
The miniskirt structure is shown in figure 2.
The structure was then stiffened by changing the sheet metal stiffness and adding folds to the edges of each of the stiffening panels and the bottom of the miniskirt as illustrated in figure 3.

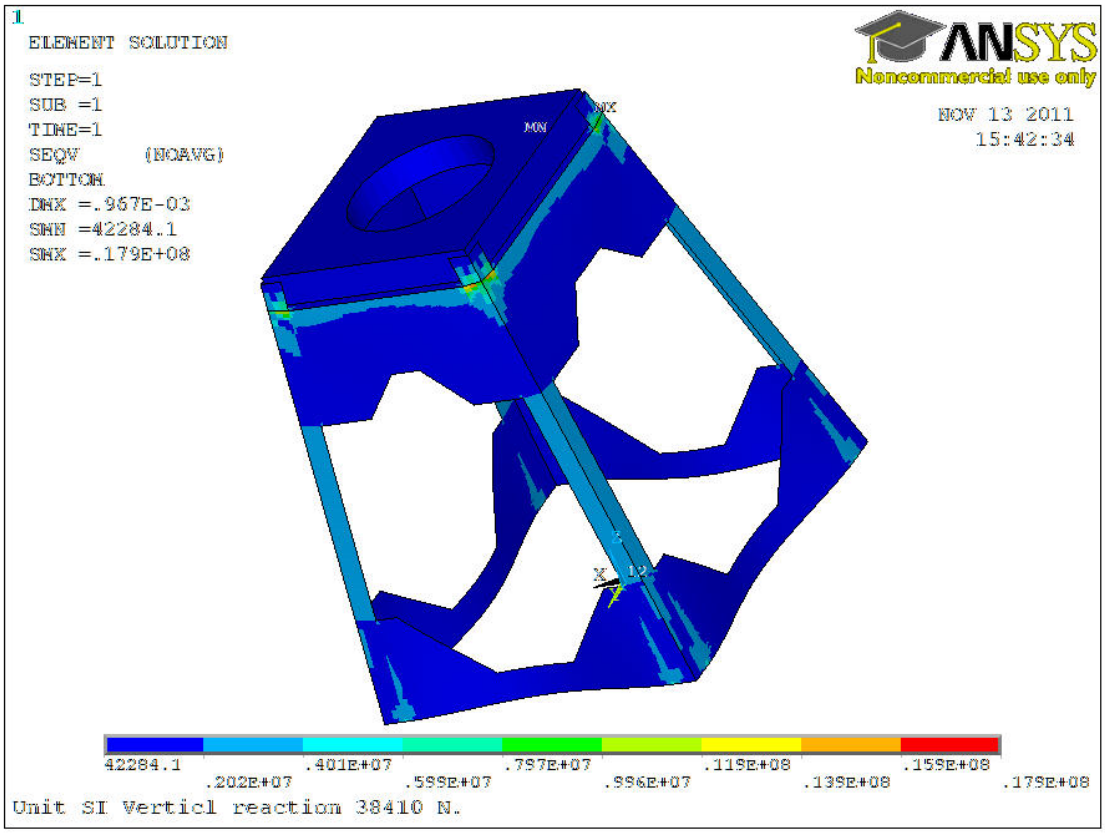


Figure 1 Initial structure concept

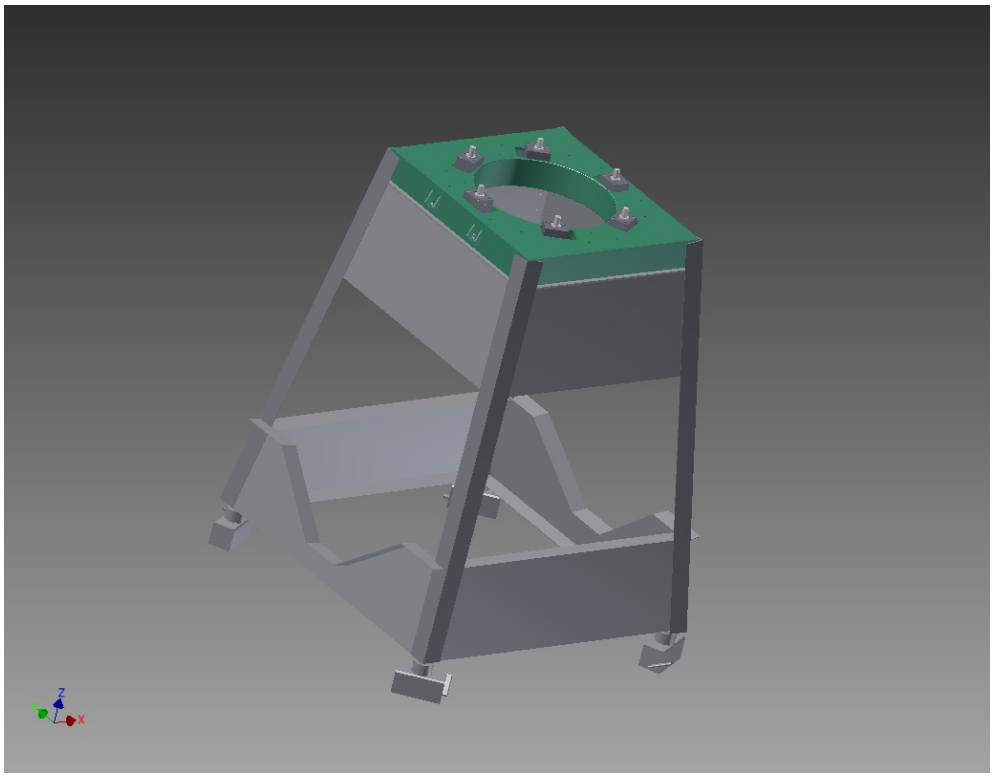


Figure 2, Structure holding the hydraulic table, with stiffening plates with folded edges.

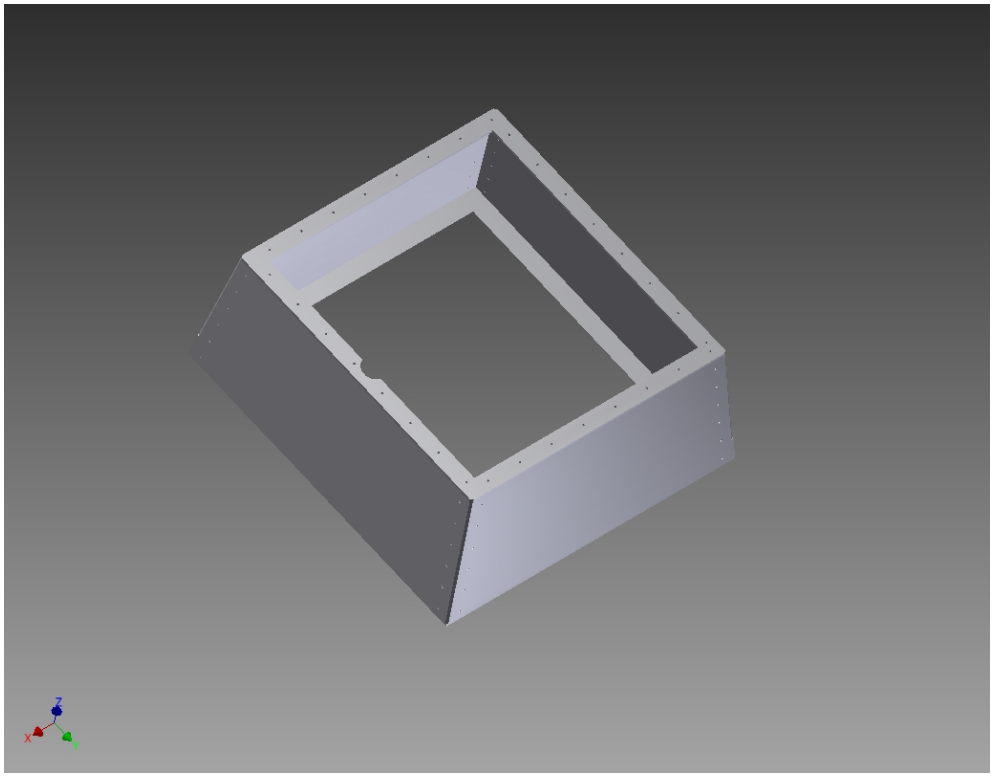


Figure 3, miniskirt with folded edges

Several versions of the structure have and are being simulated, figure 4 shows a stiffened structure which flexes only 0.09 mm at the top.
Maximum Von Mises surface stresses are 17.9 Mpa. The admissible stress within Italian rules is 140 Mpa and the plasticity stress 235 Mpa. We are in very good shape on this.
The first frequency with the initial folded miniskirt is 13. Hz (figure 4)
The first and second frequencies, with stretched skirt, but without stiffening the miniskirt, are 13.7 and 14.2 Hz (figure 5).
One can expect some small further resonant frequency increase with the stiffening fold al the stretched miniskirt, and by cutting off the sheet metal at the belly of the resonance, thus robbing it of its recoil mass.

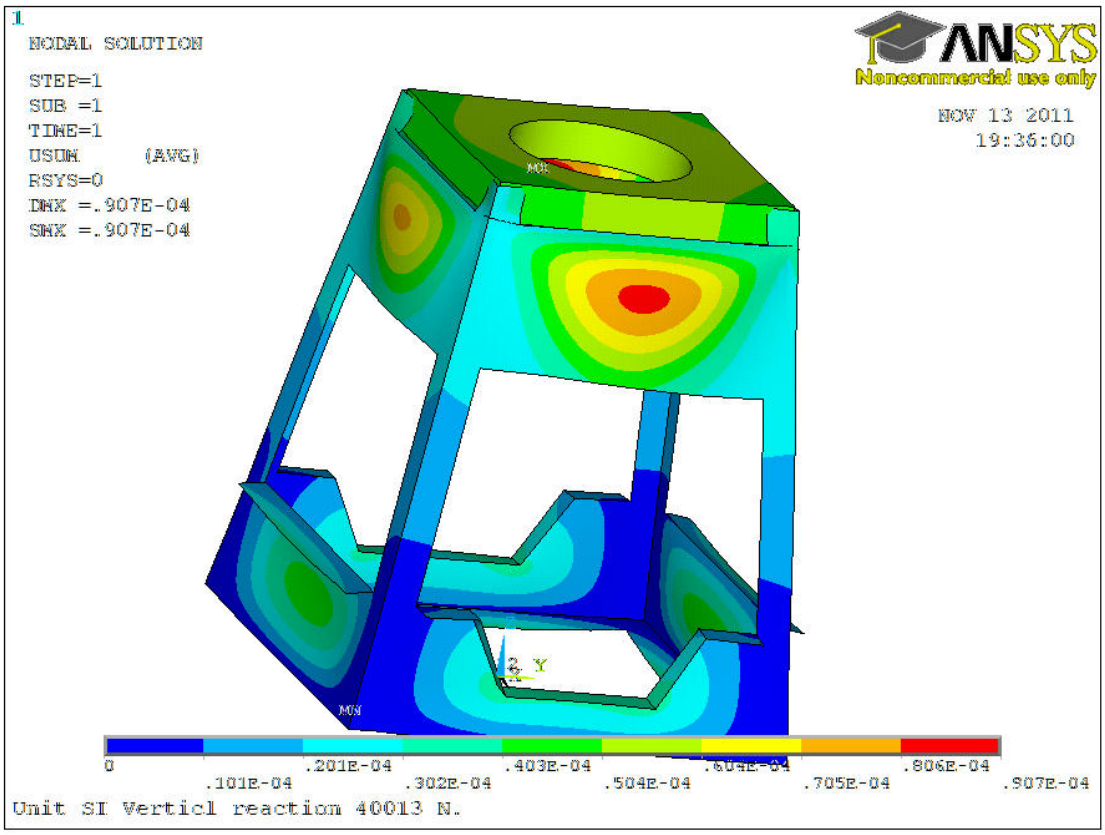


Figure 4 Stiffened structure with stretched miniskirt.

The simulations show that the stand is quite rigid, with resonances deep and safely inside the attenuation band of both Inverted Pendulum and Top Filter. Also the first resonances seem to be quadrupolar in structure, which do not entail tilt or lateral oscillation of the hydraulic table (to be further checked).
One must spend a word of caution though. The simulations of the Advanced LIGO quadruple pendulum bolted external structure predicted resonant frequencies almost double than the frequencies found in actual structures, and required replacement of the bolted structures with fully welded ones.
I believe that this was in part for a design fault in insufficient mating bolted surfaces and insufficient number of bolts (the resistance in shear is only a fraction of the force with which the bolts are tightened). For this reason we are foreseeing large overlap surfaces between the legs and the miniskirt and the stiffening panels, with a large number of bolts in a staggered pattern. Also we can de-polish the mating surfaces with sand blasting.
Despite these tricks, we should still expect actual resonant frequencies to be lower than the simulated ones.

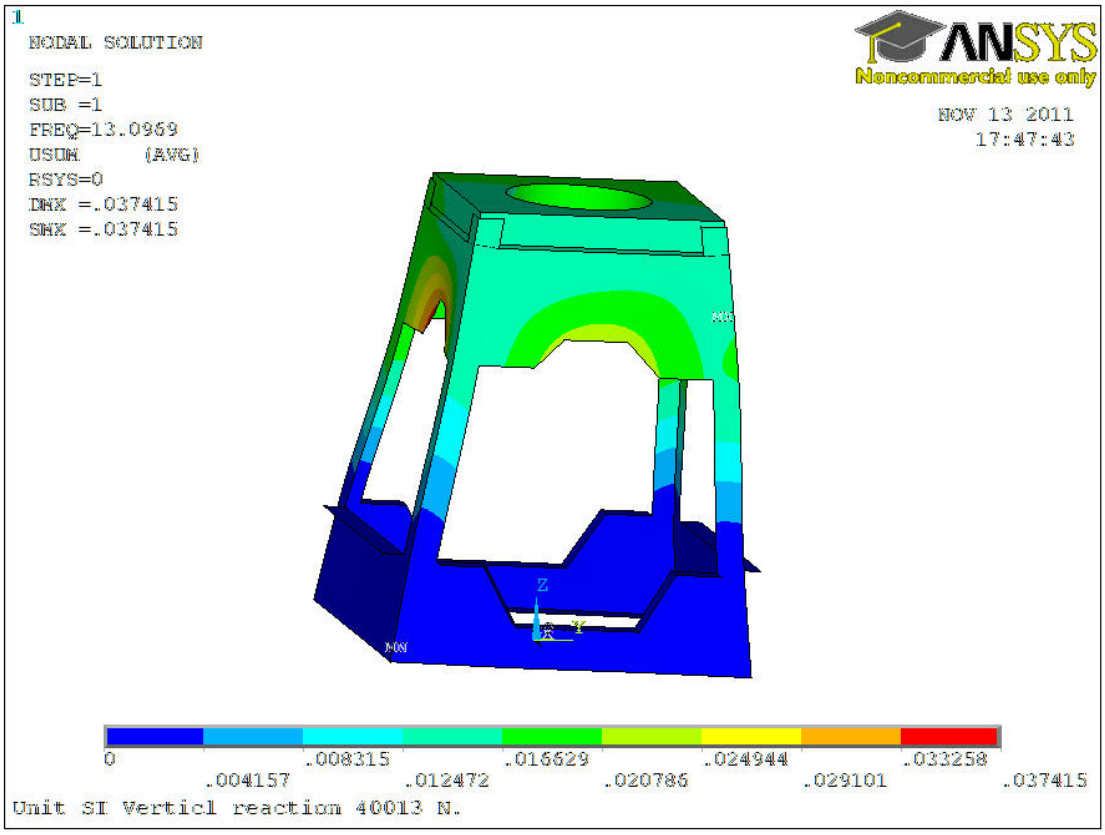
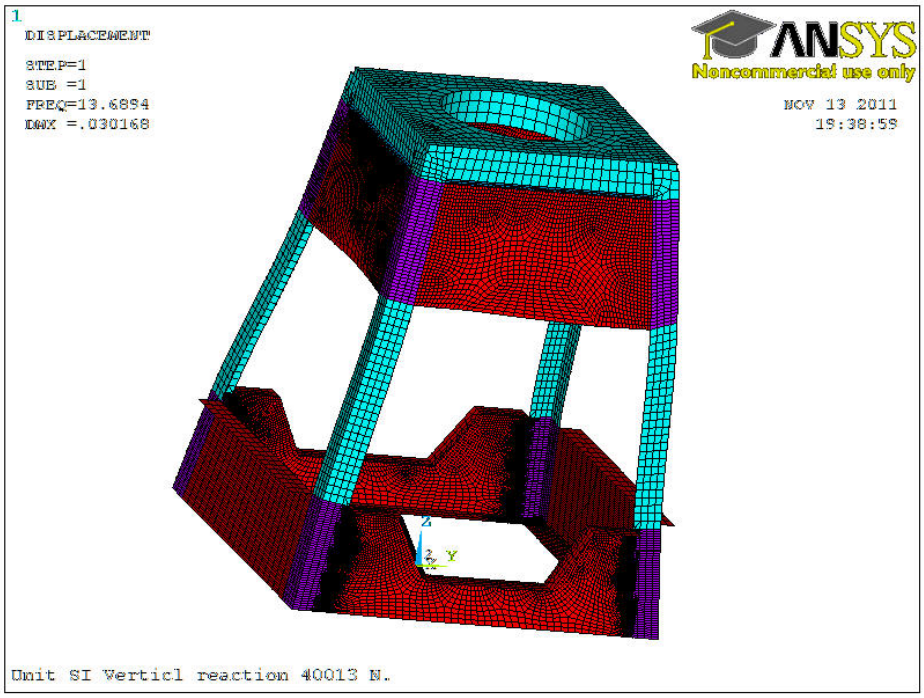


Figure 4 First resonance with the short miniskirt



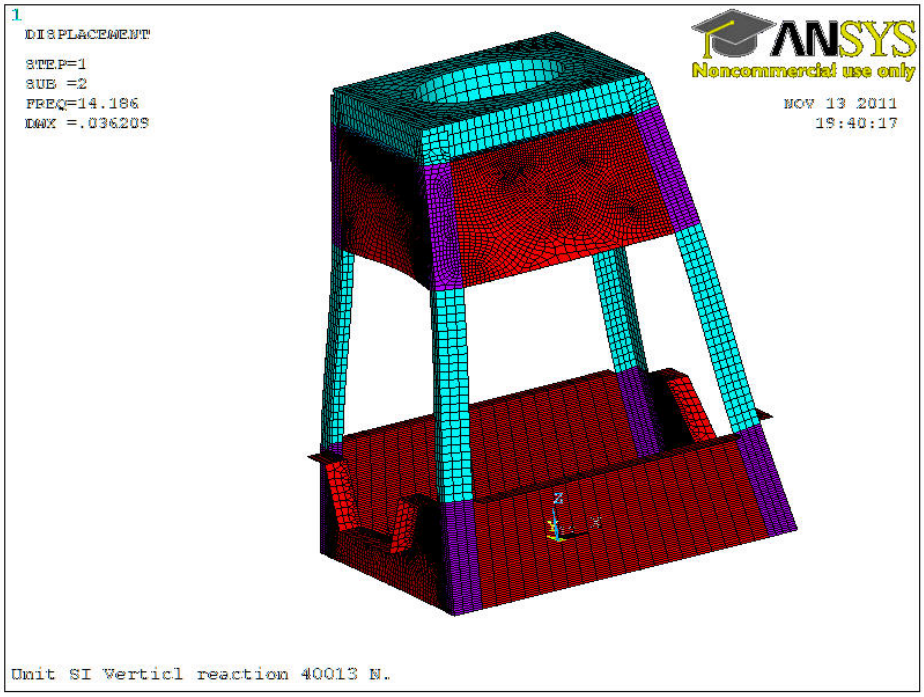


Figure 5 first and second resonance with stretched miniskirt, but without stiffeners.