



# Compressor Frame Model Increases Accuracy in Mechanical Studies

## Background

For the mechanical analysis used in API 618 (DA3), the standard approach is to assume the compressor frame is rigid and has no movement. Figure 1 shows the traditional FEA model without the compressor frame.

In reality the compressor frame is not rigid. Large forces in the compressor (refer to Figure 2) result in dynamic flexibility which affects connected piping and vessels.

In the past few years, Beta has developed super-element models for many compressor frames. The “super-element” model is then inserted in the FEA model of the compressor system to provide much higher accuracy of the mechanical system (Figure 3). This analysis technique is becoming a popular option for our DA3 studies.

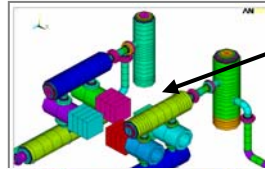


Figure 1: Standard approach, compressor frame rigid and not included in model

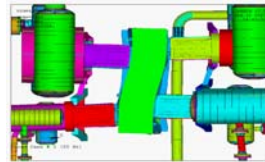


Figure 2: Compressor Frames are not rigid. See [www.BetaMachinery.com](http://www.BetaMachinery.com) for animation of compressor frame

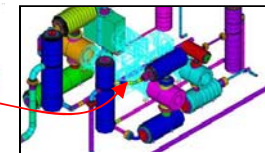


Figure 3: Super-element frame included in compressor model to improve accuracy of MNFs, vibration and stress

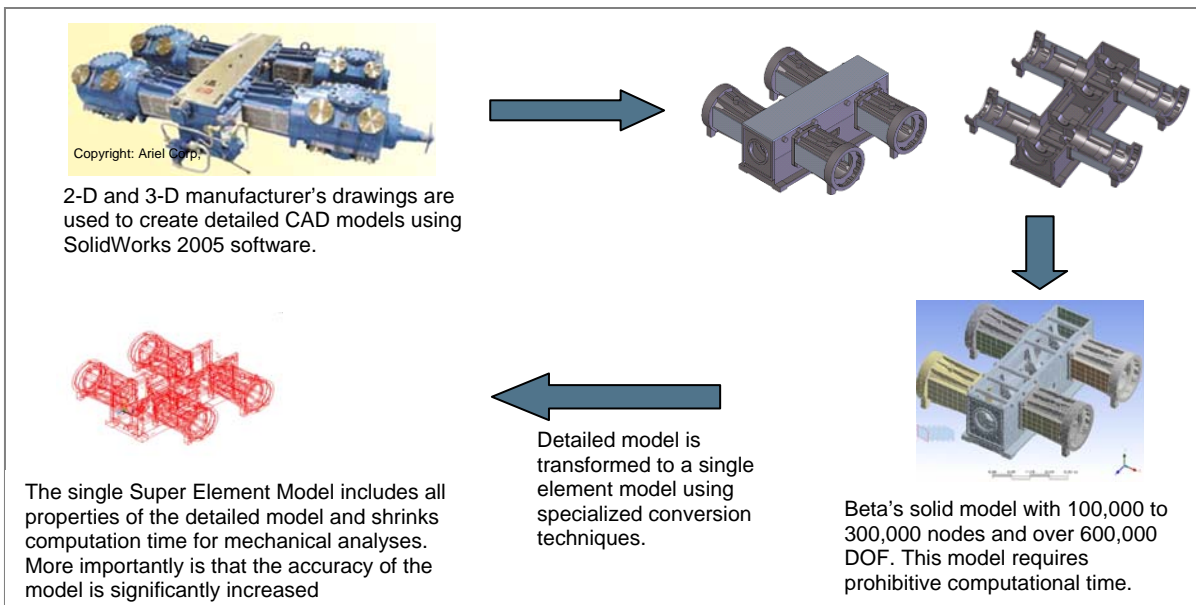


Super-element FEA frame

## Background on Super-Element Models

The “super-element” model is a proven technique for modeling complex systems. Beta pioneered this approach for reciprocating compressors and has developed a library of many different compressor frames. For a project requiring a super-element model, we simply apply the completed frame from our library to the mechanical analysis of the system. Beta can create a super-element model for other frames as required. The model accurately represents forces, moments, and other factors that affect the system.

Typical frame models have between 80,000 and 500,000 elements, 100,000 to 300,000 nodes, and between 600,000 to 1,000,000 degrees of freedom). To apply this complexity to the piping and vessels for a reciprocating compress results in excessive computational time, so while this approach is cost prohibitive, Beta’s super-element model enables our analysts to run the model in minutes.



## Summary

Including a super element model of the compressor frame in the mechanical system improves the accuracy, especially for higher frequency vibrations. The following example from a recent project illustrates the improved accuracy compared to real field data.

### Mechanical Natural Frequency Predictions (model with frame vs. field measurements)

Field	Predicted Hz	Difference
<u>Results Hz</u>	<u>(with frame)</u>	<u>%</u>
158	159	0.6%
197	194	1.5%

**Note:** these high frequency vibrations are difficult to model without the super element model. In this case *the difference the model was over 10% more accurate than the traditional approach.*