mecc alte

Power Products

Totally Focused. Totally Independent.

VIBRATION ANALYSIS

OPERATIONAL DEFLECTION SHAPES & MODE SHAPES

VERIFICATION OF ANALYTICAL MODELLING

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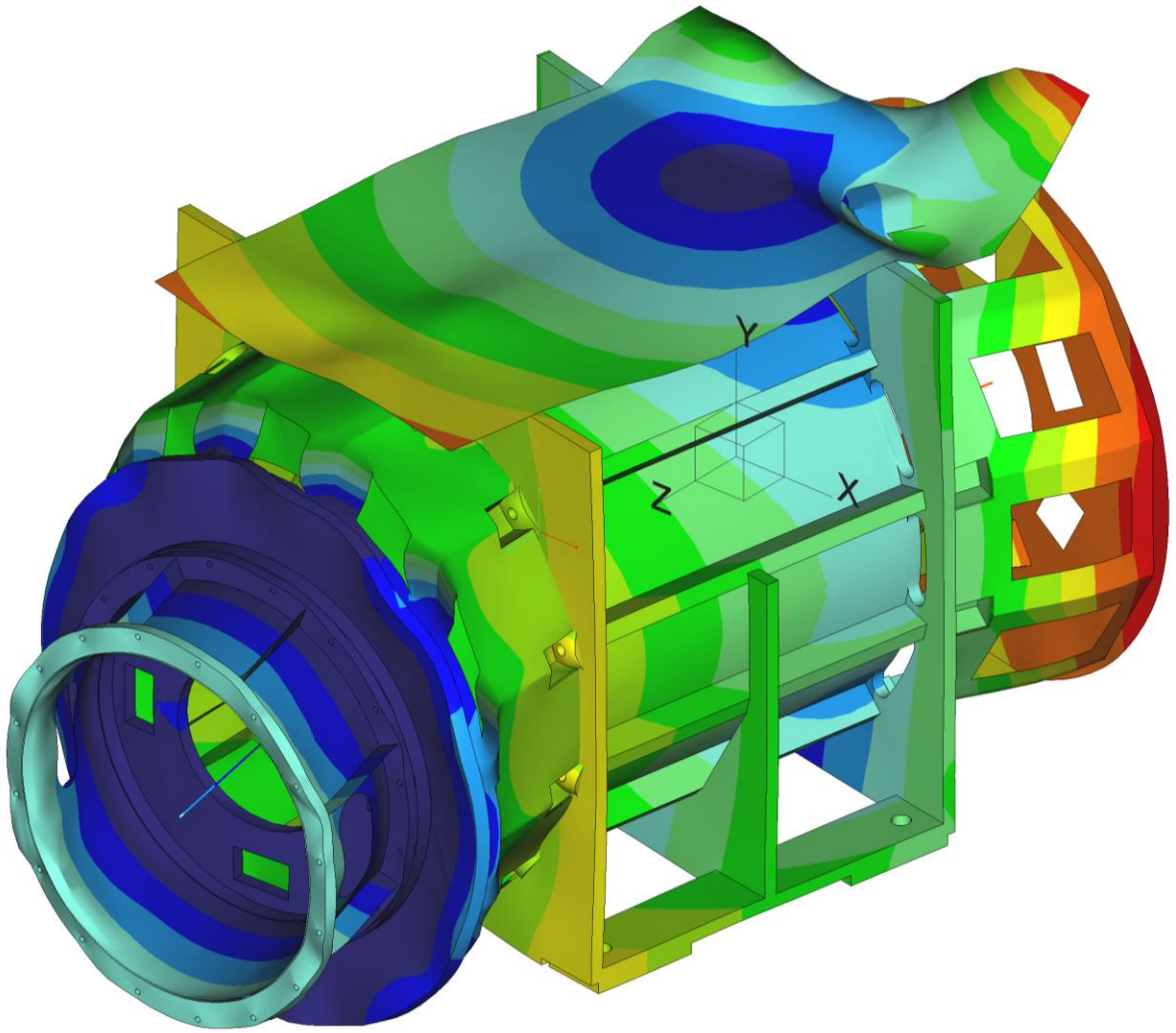


ABSTRACT

In the process of designing an alternator for genset application, it is essential to carry out some structural vibration analysis as well.

Most often this is done by performing ODS (Operating Deflection Shape Analysis) or Modal Analysis.

An **ODS** shows the deformation of a structure at a specific frequency and shows the response of a structure to both resonant and forced vibration, and is generally very representative of real world data.

Modal analysis is similar to ODS in that deformation of the structure can be viewed, but it is primarily concerned with resonance frequencies (or natural frequencies) of a structure.

INTRODUCTION

The goal of this project is to confirm the mechanical design of the Mecc Alte series ECO49, and setup a foundation method for the new series ECO47.

The project is composed of the following stages:

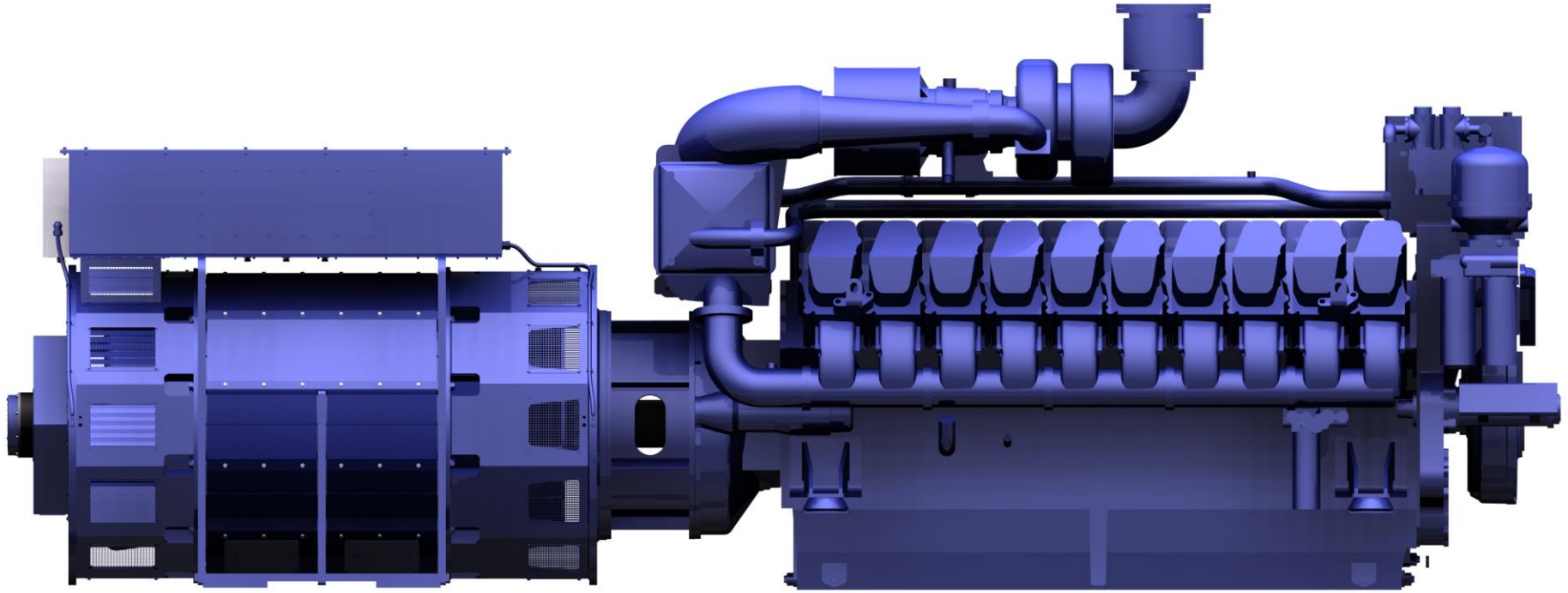
1. Acquiring the ODS's in a real genset MTU 20V4000G63 / Mecc Alte ECO 49MV-L
2. Simulate the ECO 49MV-L with a FEM software in order to model the modal parameters: natural frequencies, modal damping and shape.
3. Create a simplified virtual model of the engine, by means of a curve fitting process
4. Create a virtual test bench where simulate the alternator with different engines

The project has been developed in collaboration with CTM – Milan

EQUIPMENT UNDER TEST

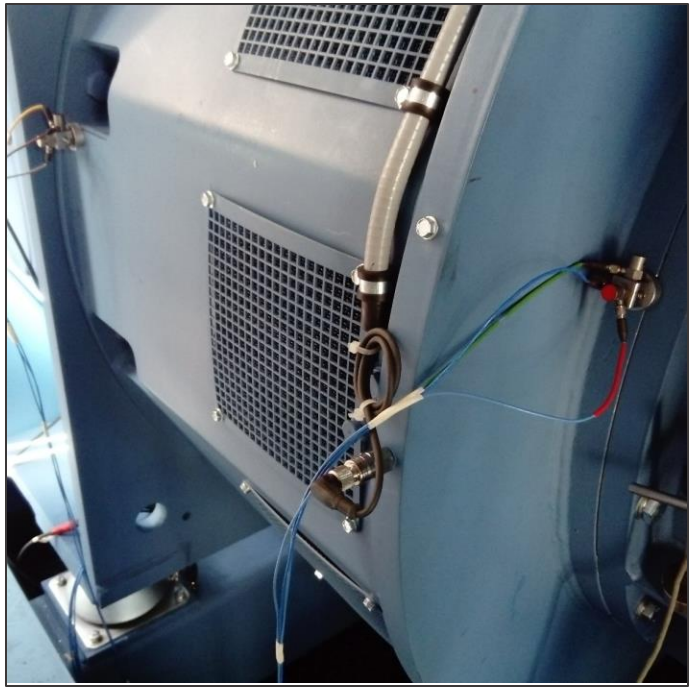
Mecc Alte ECO 49MV-L
2750kVA - 6,6kV – 50Hz

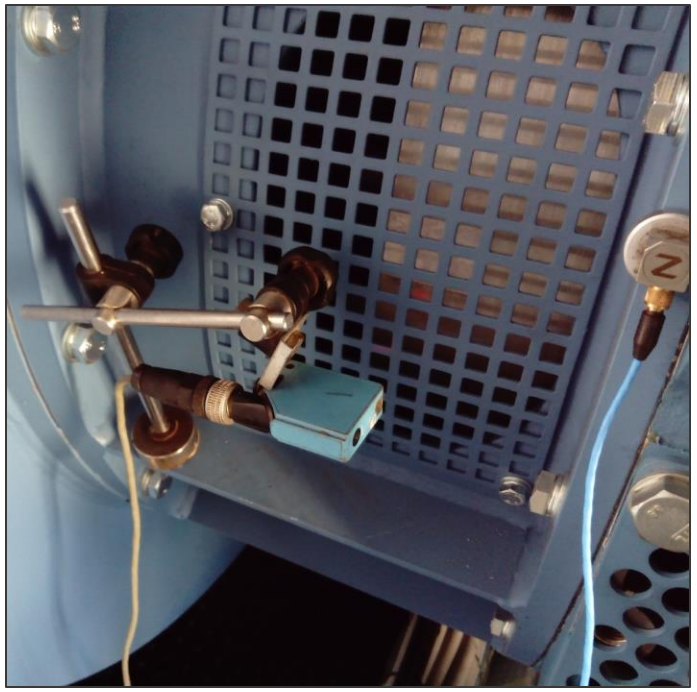
MTU 20V4000G63
2000kW – 1500rpm

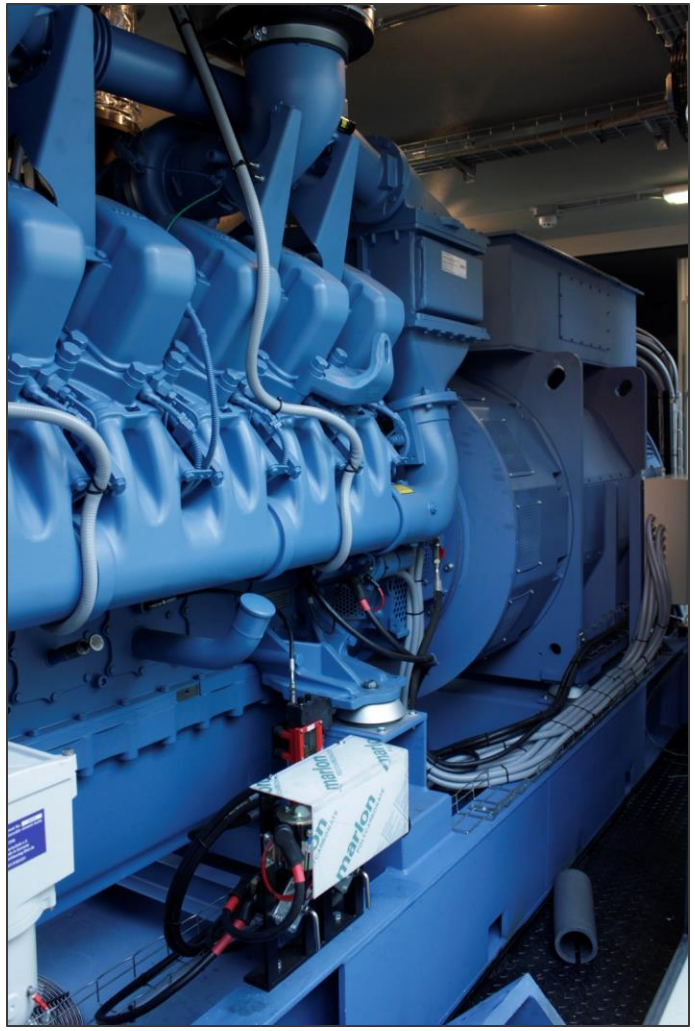


ODS's MEASUREMENT

The ODS's were acquired during the commissioning of the genset in December 2017, at the clients factory.





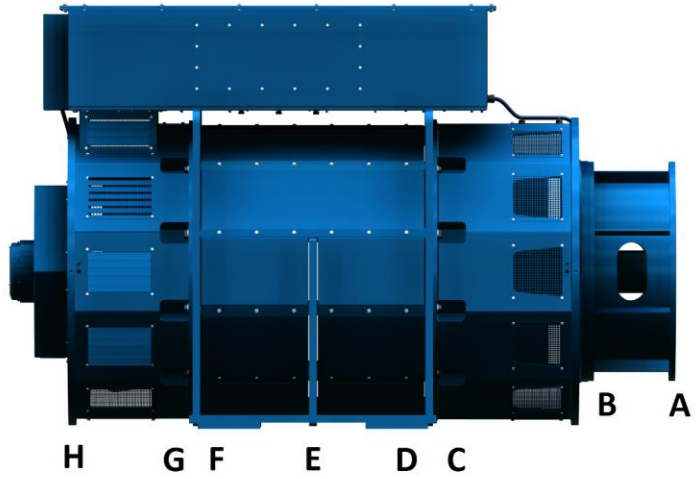


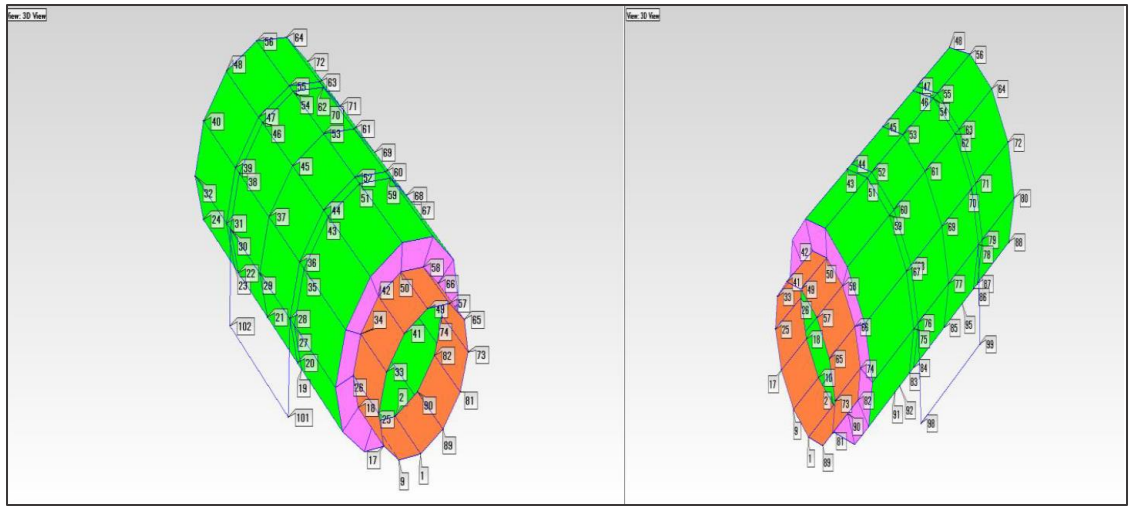
ODS's MEASUREMENT

The vibrations are measured on the alternator with 8 triaxial accelerometers in 12 different points

We acquired in total 288 different traces on the frame and 306 traces on the feet, at 0%, 75% and 100% of the load.

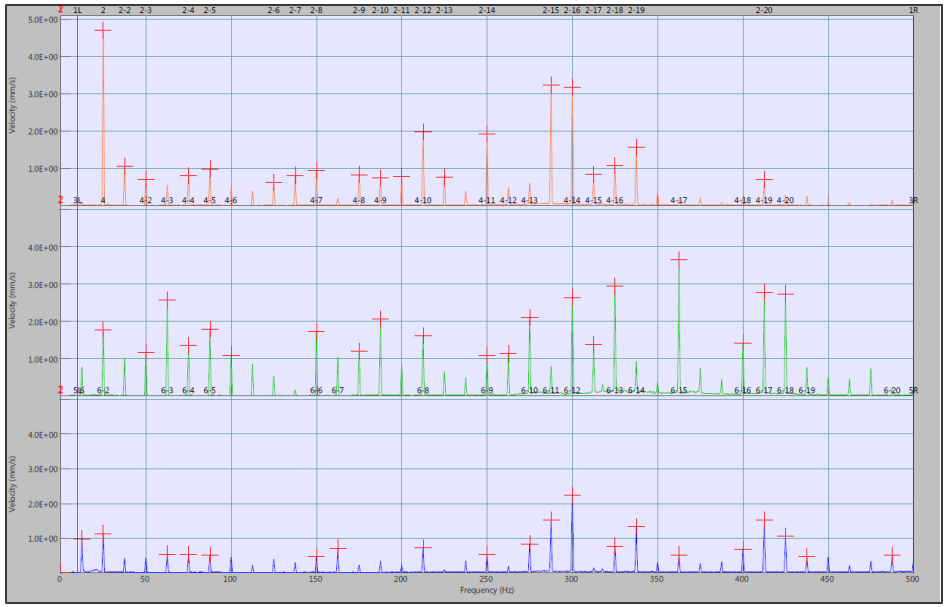
On each of these traces an FFT analysis 10-500 Hz was performed and with a specific software the deflection shapes were determined

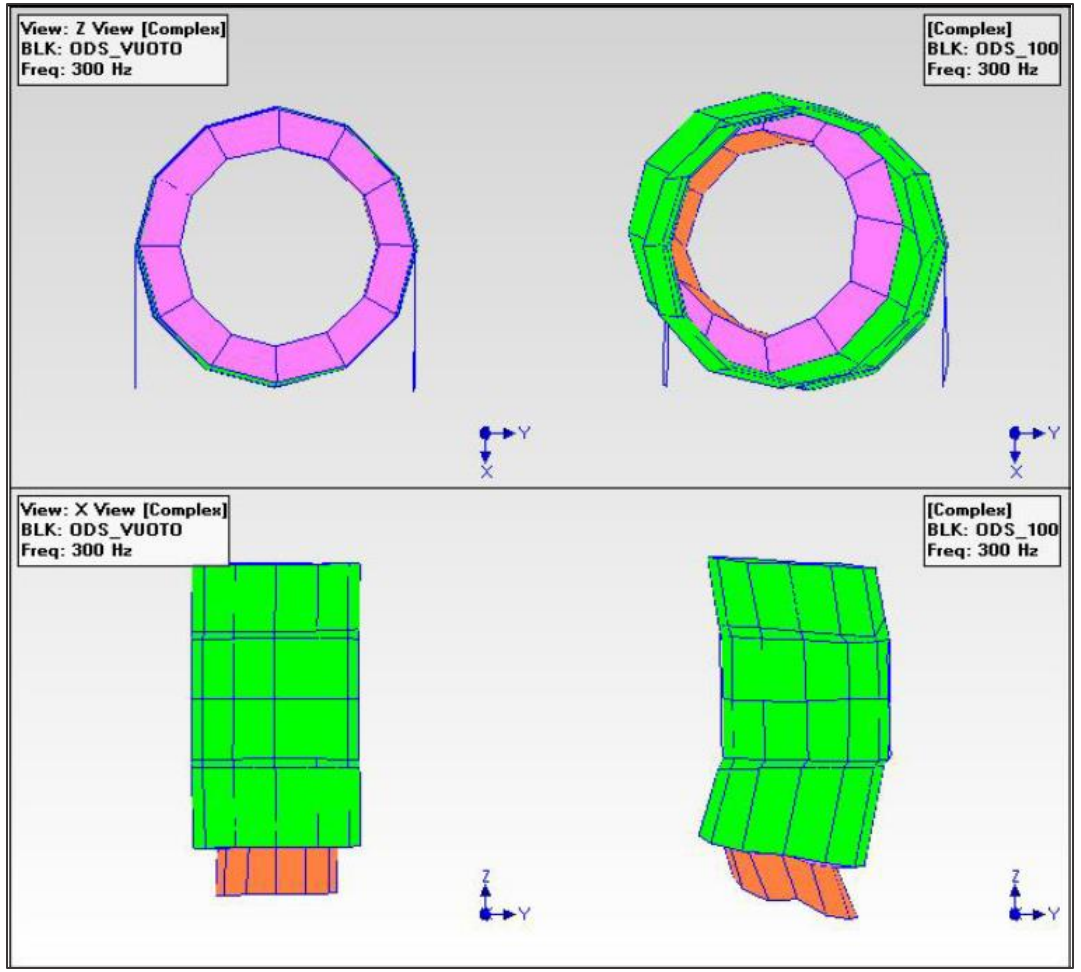




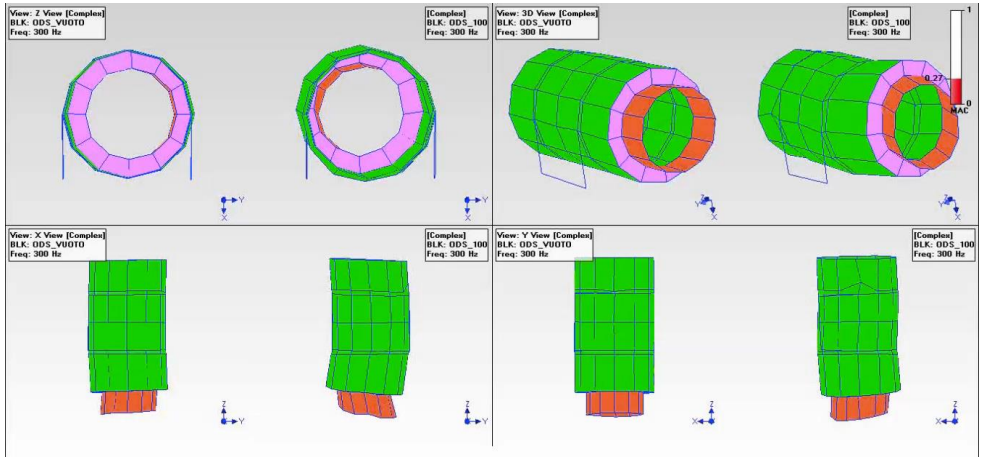
ODS's MEASUREMENT

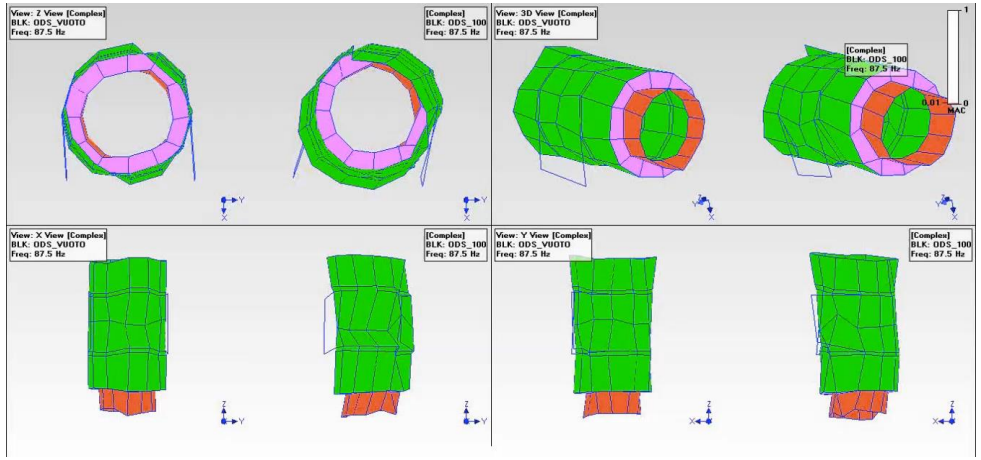
From the FFTs to the operative deflection shapes

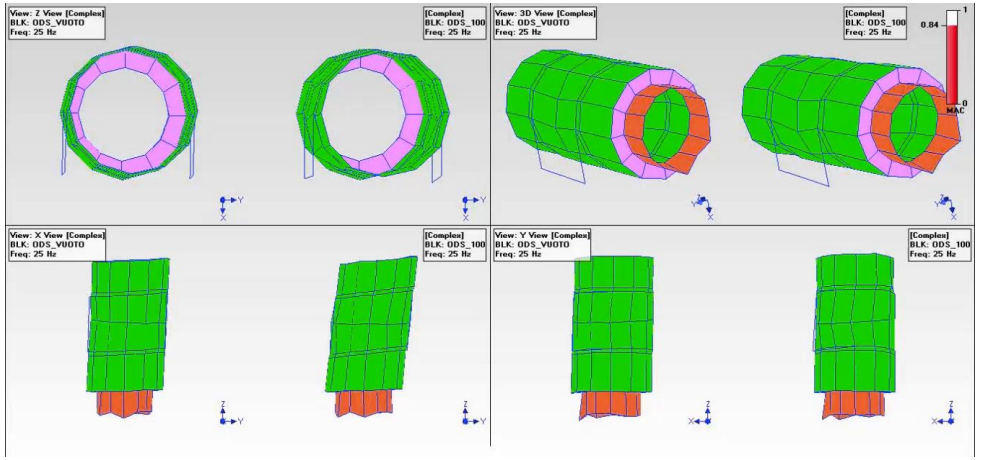


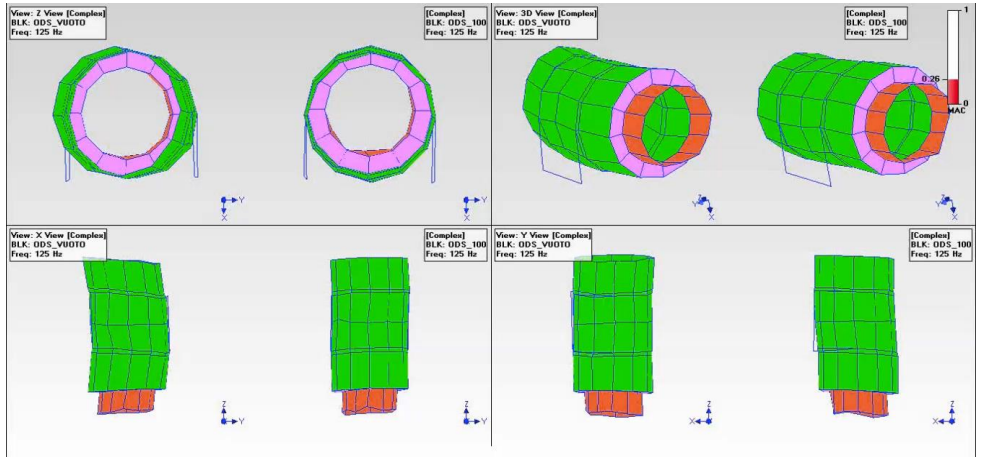


ODS's MEASUREMENT





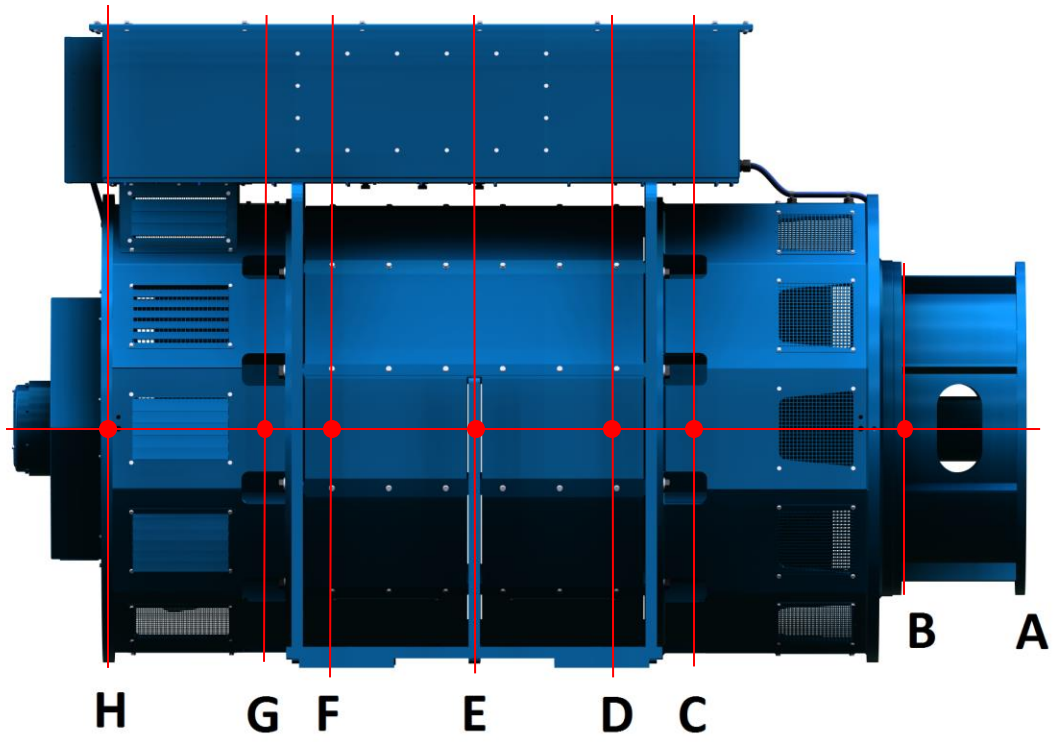




RMS VALUES 10-1000HZ

Vibrations acquired on the alternator frame, horizontal axle [mm/s rms]

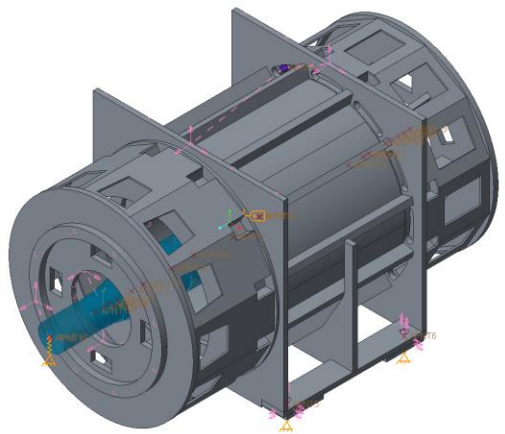
Point	Load 0%	Load 75%	Load 100%
B	4.0	6.7	8.0
C	3.1	3.2	4.0
D	3.1	3.4	3.9
E	3.5	3.9	4.5
F	5.0	5.6	6.0
G	5.5	6.2	6.8
H	6.8	8.6	10.2

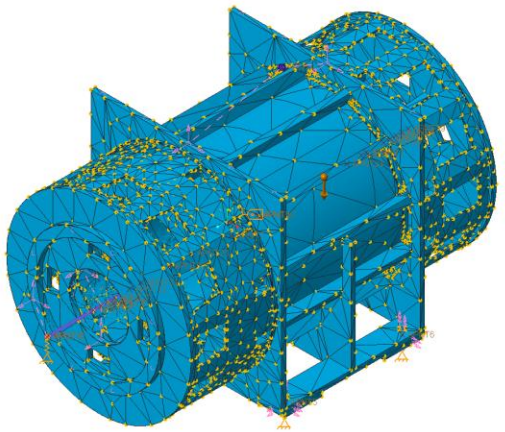


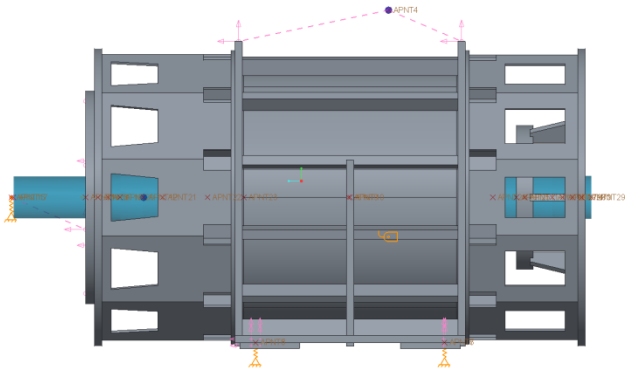
ECO49 FEM SIMULATION

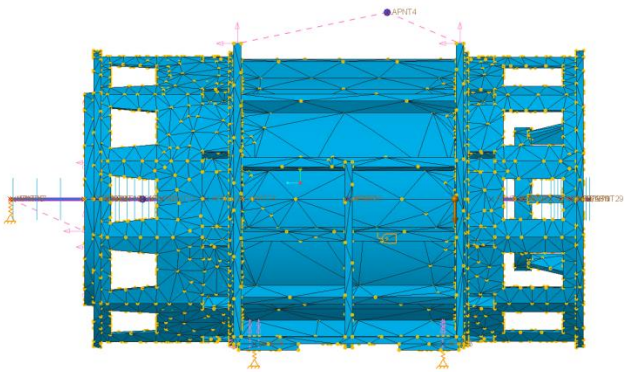
The modal shapes are determined by using a finite element model of the alternator

We found 27 different modal shapes from 4 to 150 Hz

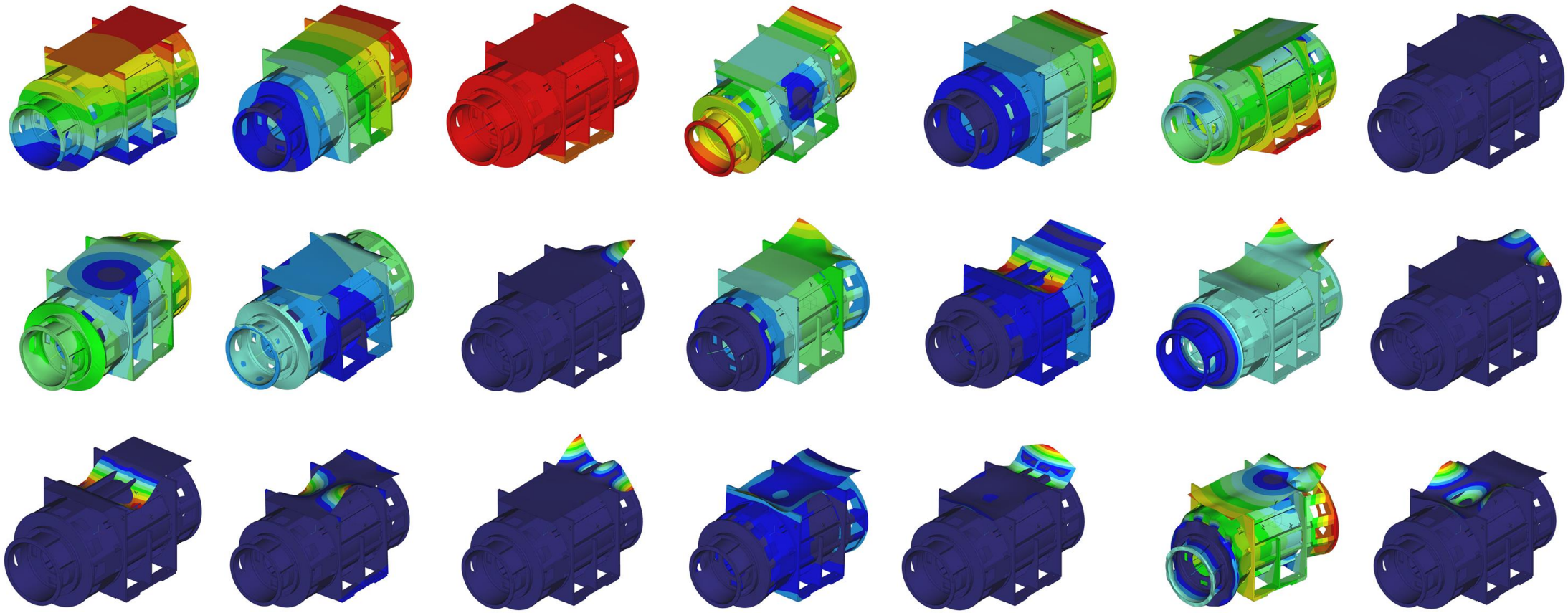








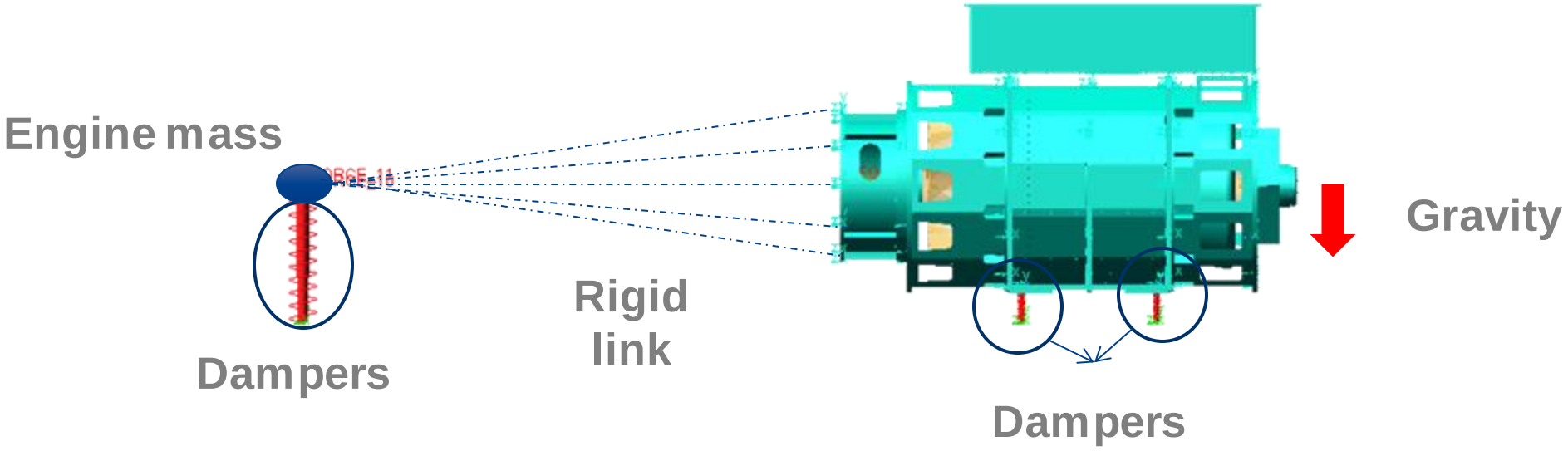
ECO49 MODAL SHAPES



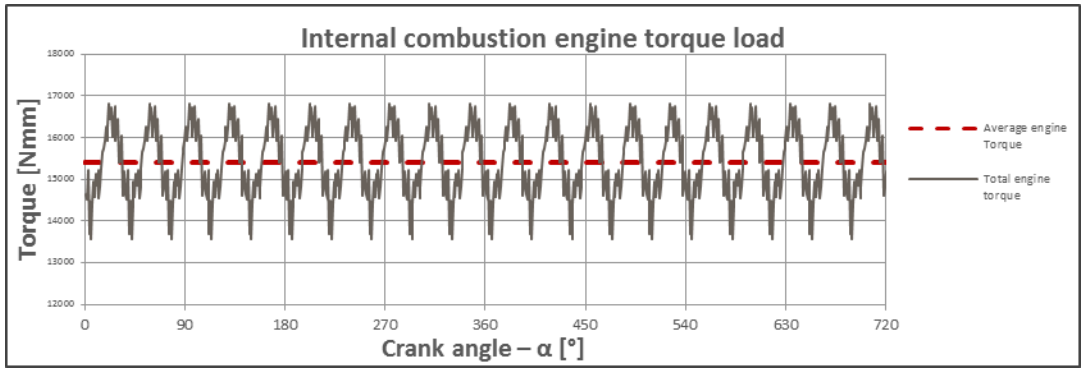
ENGINE MODEL

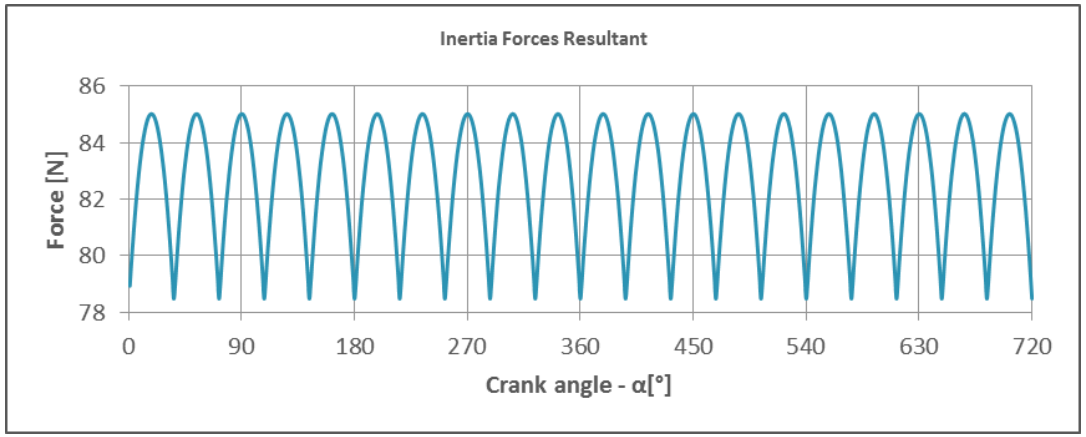
Engine weight & Inertia	
Massa [kg]	9640
Ixx [kg mm²]	1.0e+10
Iyy[kg mm²]	1.02e+10
Izz[kg mm²]	4.25e+9

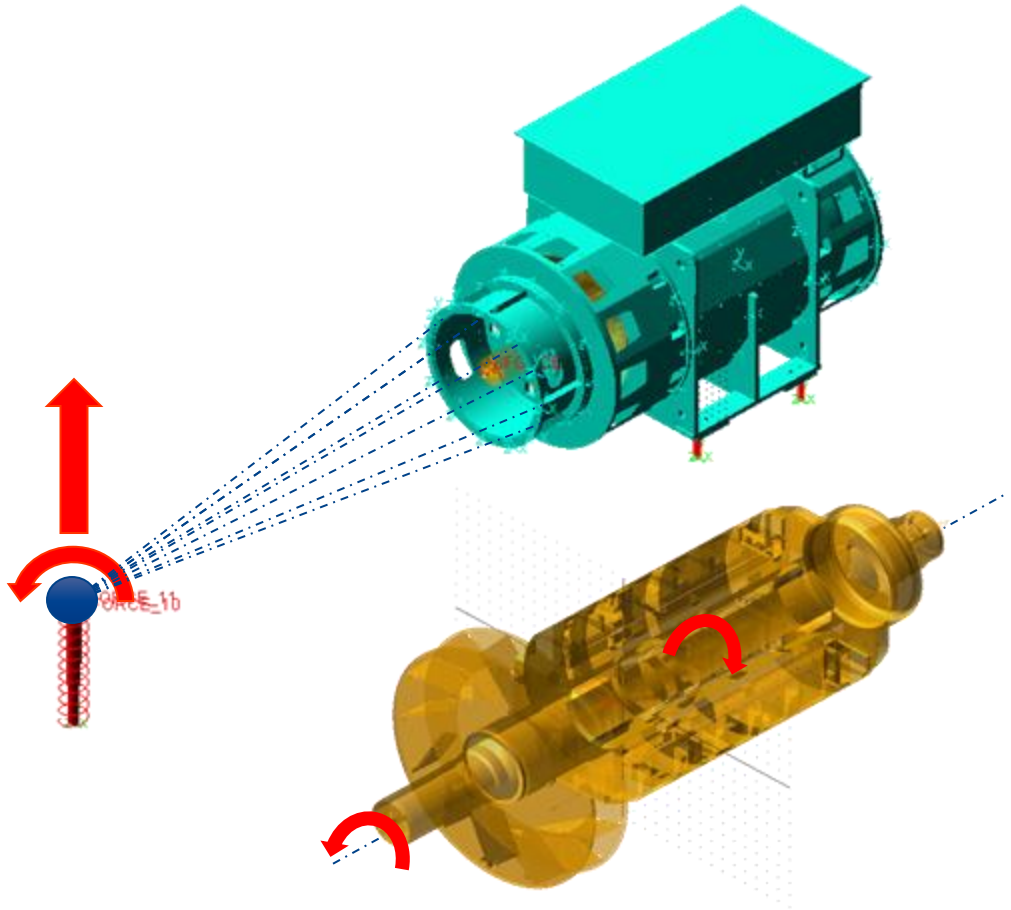
Dampers Stiffness [N/mm]	
Generator	10^9
Engine	10^9



LOADS INTRODUCED BY THE ENGINE

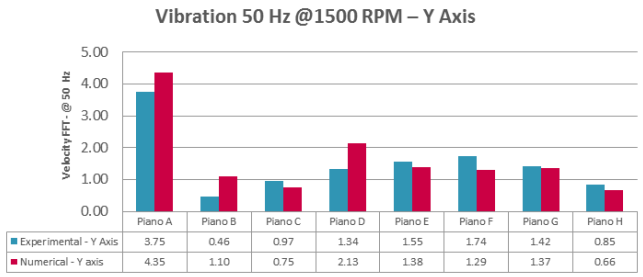




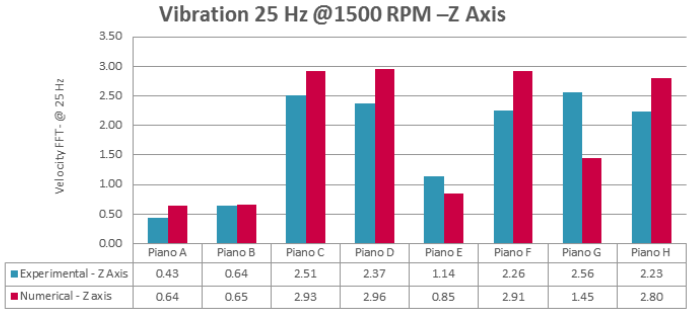


CURVE FITTING

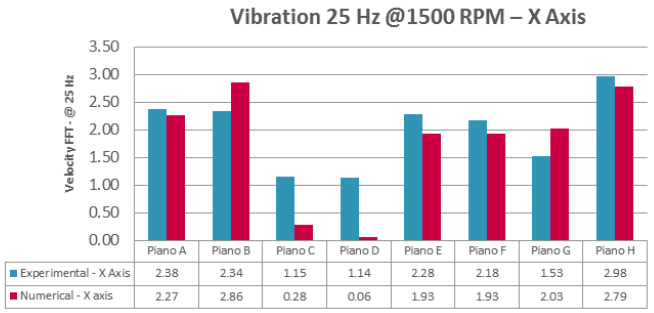
We created a virtual genset, and adapted the modal parameters, comparing the analytical data with the sampling acquired in the field, minimizing the square errors.



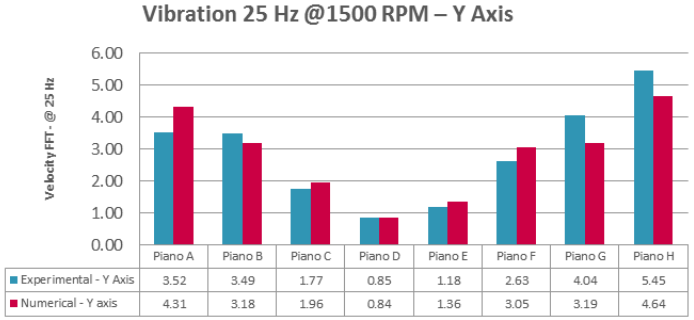
	Piano A	Piano B	Piano C	Piano D	Piano E	Piano F	Piano G	Piano H
Experimental - Y Axis	3.75	0.46	0.97	1.34	1.55	1.74	1.42	0.85
Numerical - Y axis	4.35	1.10	0.75	2.13	1.38	1.29	1.37	0.66



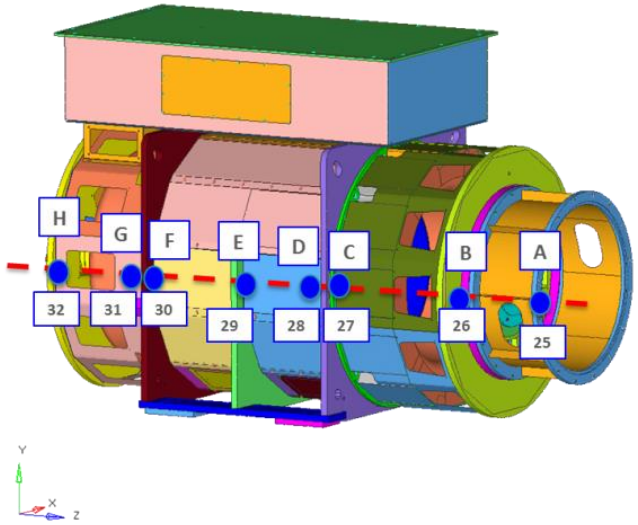
	Piano A	Piano B	Piano C	Piano D	Piano E	Piano F	Piano G	Piano H
Experimental - Z Axis	0.43	0.64	2.51	2.37	1.14	2.26	2.56	2.23
Numerical - Z axis	0.64	0.65	2.93	2.96	0.85	2.91	1.45	2.80



	Piano A	Piano B	Piano C	Piano D	Piano E	Piano F	Piano G	Piano H
Experimental - X Axis	2.38	2.34	1.15	1.14	2.28	2.18	1.53	2.98
Numerical - X axis	2.27	2.86	0.28	0.06	1.93	1.93	2.03	2.79



	Piano A	Piano B	Piano C	Piano D	Piano E	Piano F	Piano G	Piano H
Experimental - Y Axis	3.52	3.49	1.77	0.85	1.18	2.63	4.04	5.45
Numerical - Y axis	4.31	3.18	1.96	0.84	1.36	3.05	3.19	4.64



CONCLUSION

1. **Vibrations acquired on the CTM project are below ISO 8528 limits and safe for the genset**

2. **We have setup a virtual test bench, to estimate the vibrations in a specific condition, even with different engines**

3. **We can help the customer in case of abnormal vibrations**

4. **We have defined a methodology to be used for the approval of other series and the design of the new series ECO47**

ISO 8528 COMPLIANT

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