ROSETTI MARINO

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Sign	Date
	08-08-2024

Base Load Power Hub (BLPH)

VIBRATION ANALYSIS DATA-LATERAL ANALYSIS
For Sea Water Lift Progressive Cavity Pumps (P-50001 A/B)

Document Number: 1724000936-MAC-RE-00003

Document Class: 3

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Rev.	Date	Description	Prepared	Reviewed	Approved

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Revision / Change Log

Rev.	Description
00	Issue for Information (IFI)
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1	
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STUDY REPORT

Vibration Analysis of pump shaft and casing

Project: Hollandse Kust Noord Wind Park – CrossWind / Rosetti Marino

PROGRESSIVE CAVITY PUMP - P-50001 A/B.

Abstract: *Modal analysis of the pump shaft and the pump casing were made to ensure the proper frequency of the pump is out of the operating range of the pump.*

By	Checked	Approved
APD	HDT	GPE

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1. Introduction

Both pump casing and shaft modal analysis are performed separately. The structure is modelled according to the locations of the centralizers indicated on the document 1724000936-MAC-DA-00004 (GAD of P-50001A/B). See attachment for the centralizer's locations.

Number of PCM pumps: 2

Tag: P-50001 A/B.

The operating speed of the pumps being 118 rotation/minute= 1.97 hertz, the first eigen frequencies must be superior to this value. The modal analysis has been performed multiple times with decreasing mesh sizes until there is no significant change in the 1st mode shape frequency value.

2. Calculation

2.1. Shaft line only

The calculation is performed on the below part:

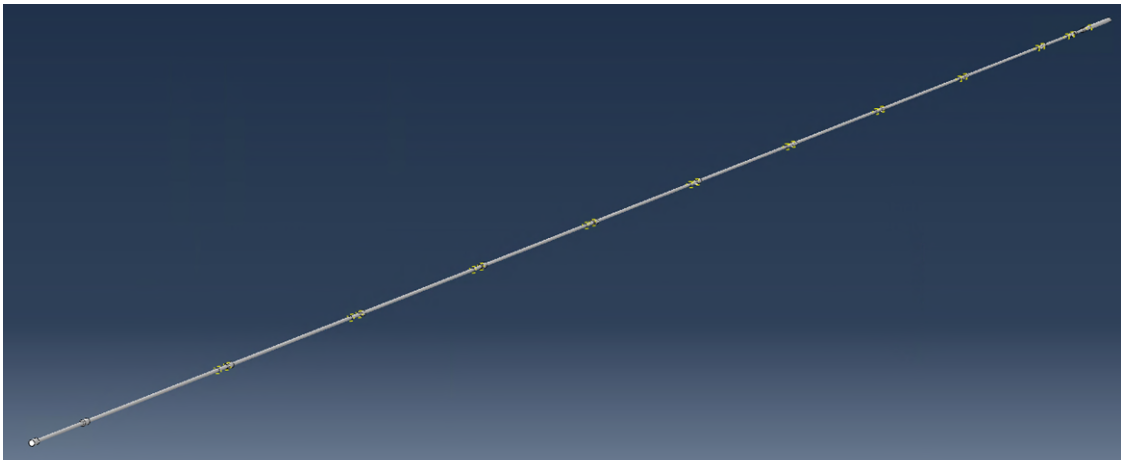


Figure 1: Shaft Line Model

- Meshing

The meshing characteristics are listed in Table 1 below:

	Elements Number	Nodes Number	Type
SHAFT 25AV24	80599	147814	Tetrahedral quadratic elements (C3D10)

Table 1: Meshing characteristics

- Material

The material and its properties are defined in the below Table 2. These values are considered at ambient temperature.

Material	Young Modulus E [GPa]	Poisson ratio ν [-]	Density ρ [Ton/mm3]
Super Duplex Stainless Steel	200	0.3	7.8 E-09

Table 2: Material Properties

- Boundary Conditions

The top of the shaft is fixed in all directions to simulate the impact of the mechanical seal on the shaft.

We highlighted the surfaces in contact with the internal centralizers and the stator. These surfaces are fixed in both lateral directions to simulate the operating conditions. For our calculation, we do not consider the stiffness of the centralizers because, as per experience, the centralizers are stiff enough to be considered as fixed points.

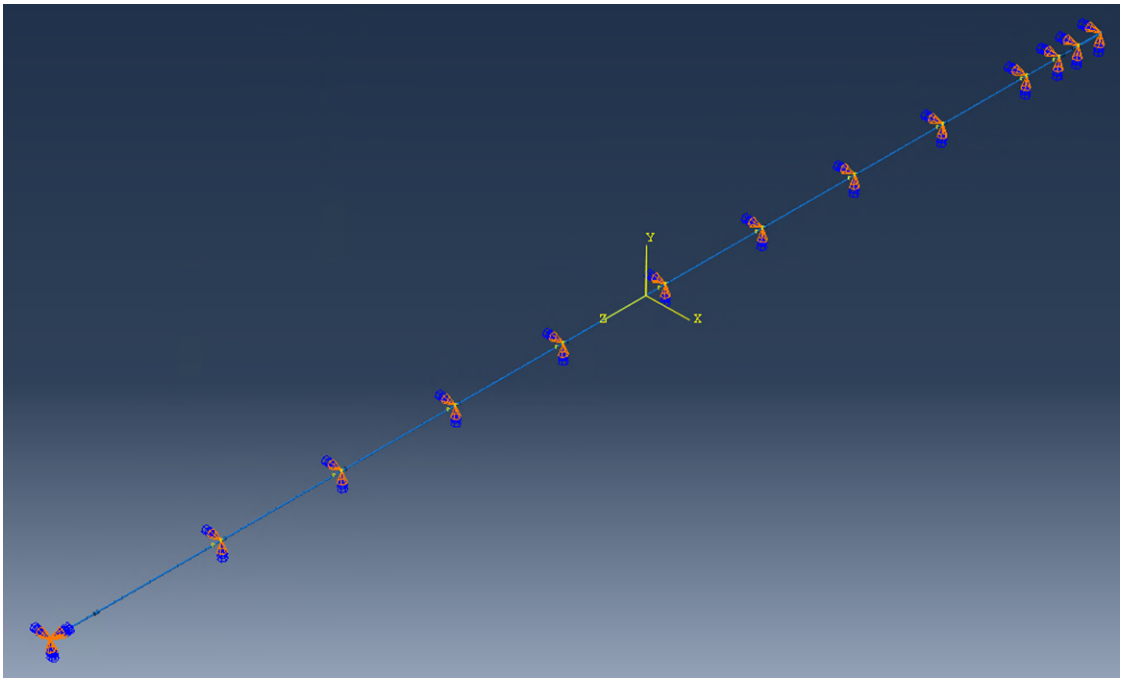


Figure 2: Shaft line boundary conditions modeling

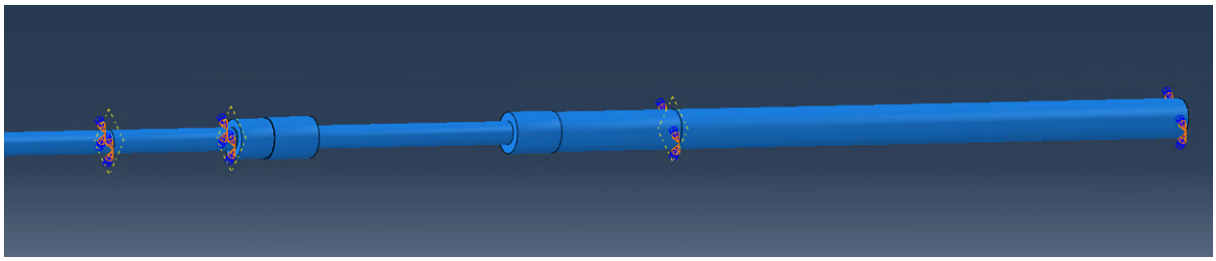


Figure 3: Shaft line boundary conditions details

- Load

No load is applied to the system for this modal analysis.

2.2. Casing Only

The calculation is performed on the below part:

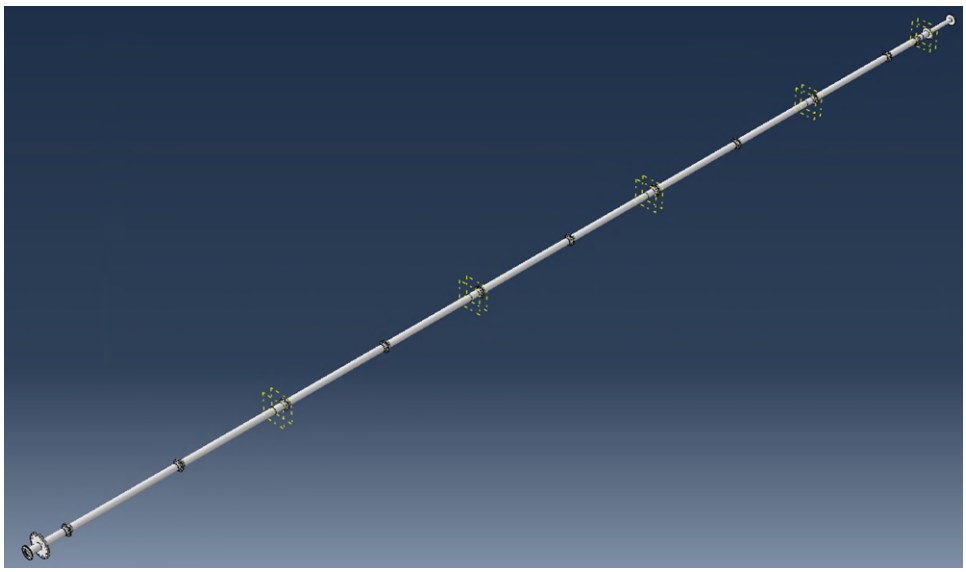


Figure 4: Pump Casing Model

- Meshing

The meshing characteristics are listed in Table 3 below:

	Elements Number	Nodes Number	Type
Casing 25AV24	493833	946598	Tetrahedral quadratic elements (C3D10)

Table 3: Meshing characteristics

- Material

The material is similar to the one used for the shaft line. See Table 2 for the properties of the material.

- Boundary Conditions

The below surface of the mounting flange is fixed in all directions and serves as anchor point.

We highlighted the surfaces in contact with the external centralizers. These surfaces are fixed in both lateral directions to simulate the operating conditions. For our calculation, we do not consider the stiffness of the centralizers because, as per experience, the centralizers are stiff enough to be considered as fixed points.

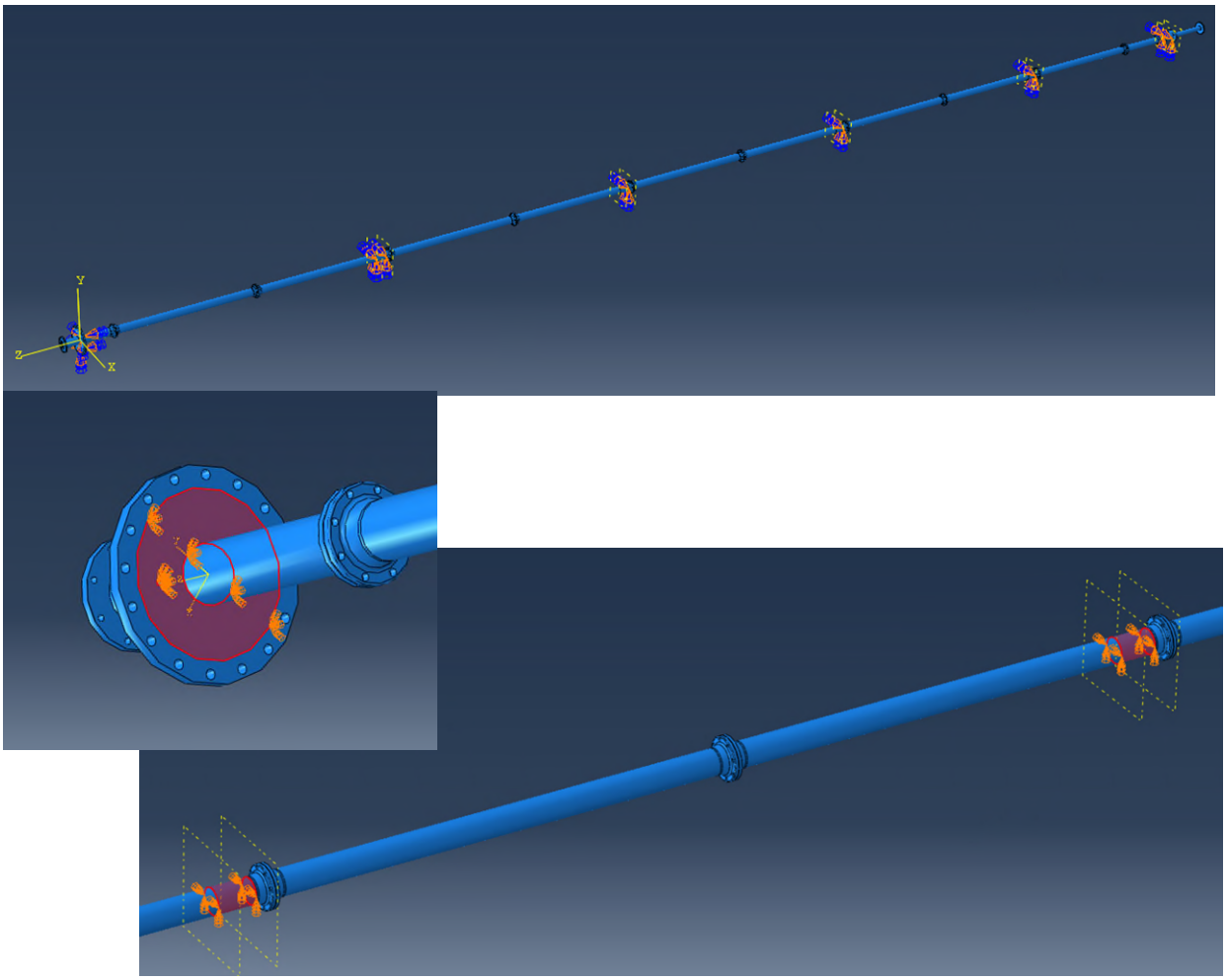


Figure 5: Pump Casing boundary conditions modeling

- Load

No load is applied to the system for this modal analysis.

3. Results

3.1. Shaft line only

The first eigen frequency value of the shaft line is 11.1 Hz. It is significantly larger than maximum excitation frequency of 1.97 Hz. Item eigen frequency is not presenting any issue on the shaft line integrity.

The part of the shaft line affected at this frequency is located between the mechanical seal and the first centralizer.

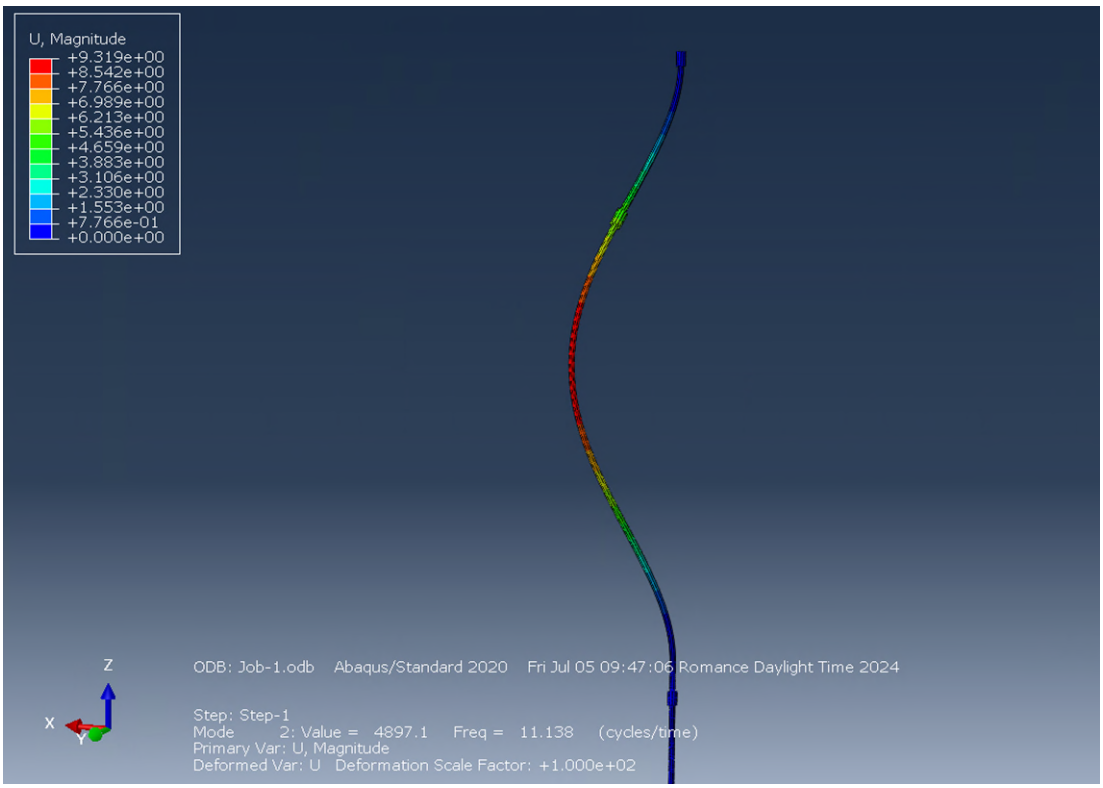


Figure 6: First eigen frequency value for the shaft line

The second frequency of excitation is at 20.6 Hz. This frequency corresponds to the eigen value of the shaft extension located between two centralizers.

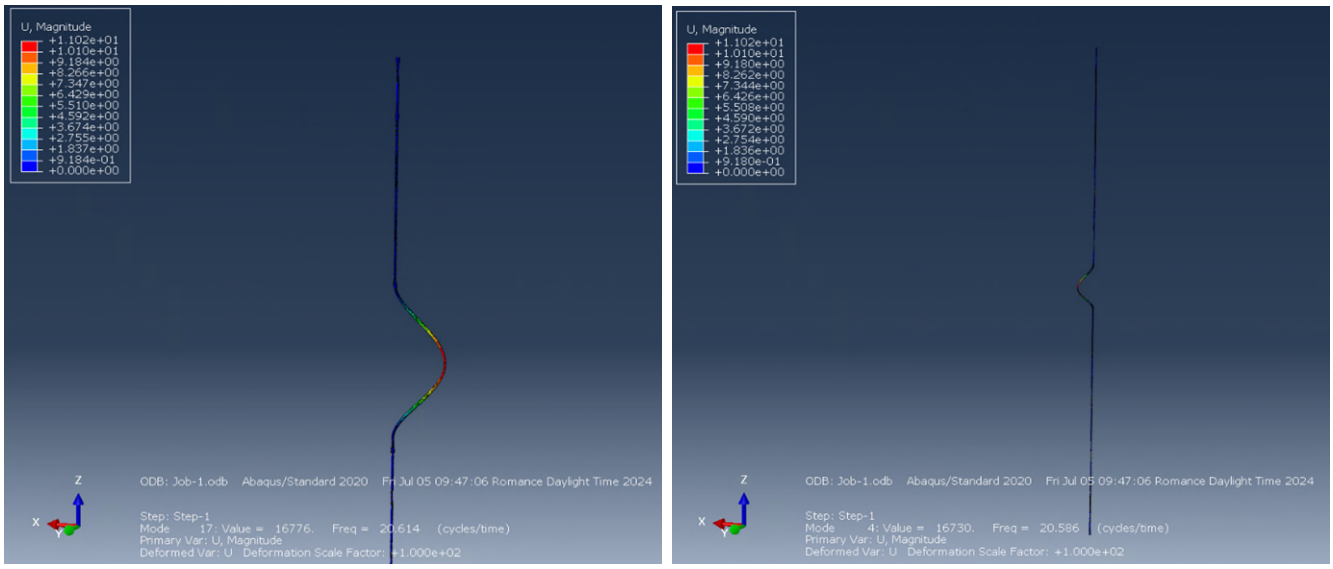


Figure 7: Second eigen frequency value for shaft line

The third eigen frequency value for the shaft line was recorded at 30.3 Hz.

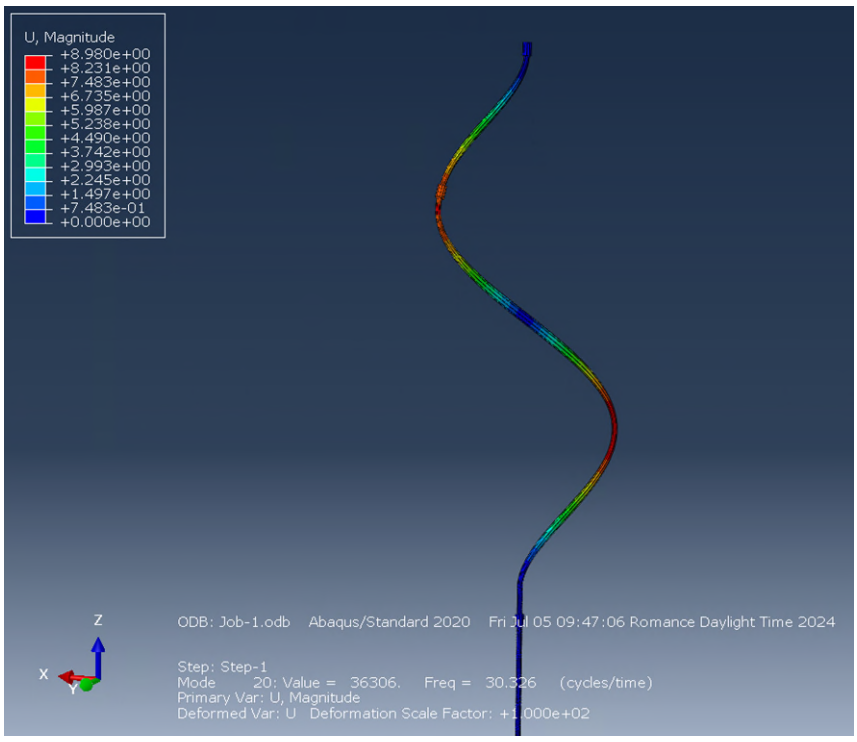


Figure 8: Third eigen frequency value for shaft line

3.2. Pump Casing only

For the pump casing, the first eigen frequency value is recorded at 22.4 Hz. It is larger than the first eigen value for the shaft line and consequently significantly larger than maximum excitation frequency of 1.97 Hz.

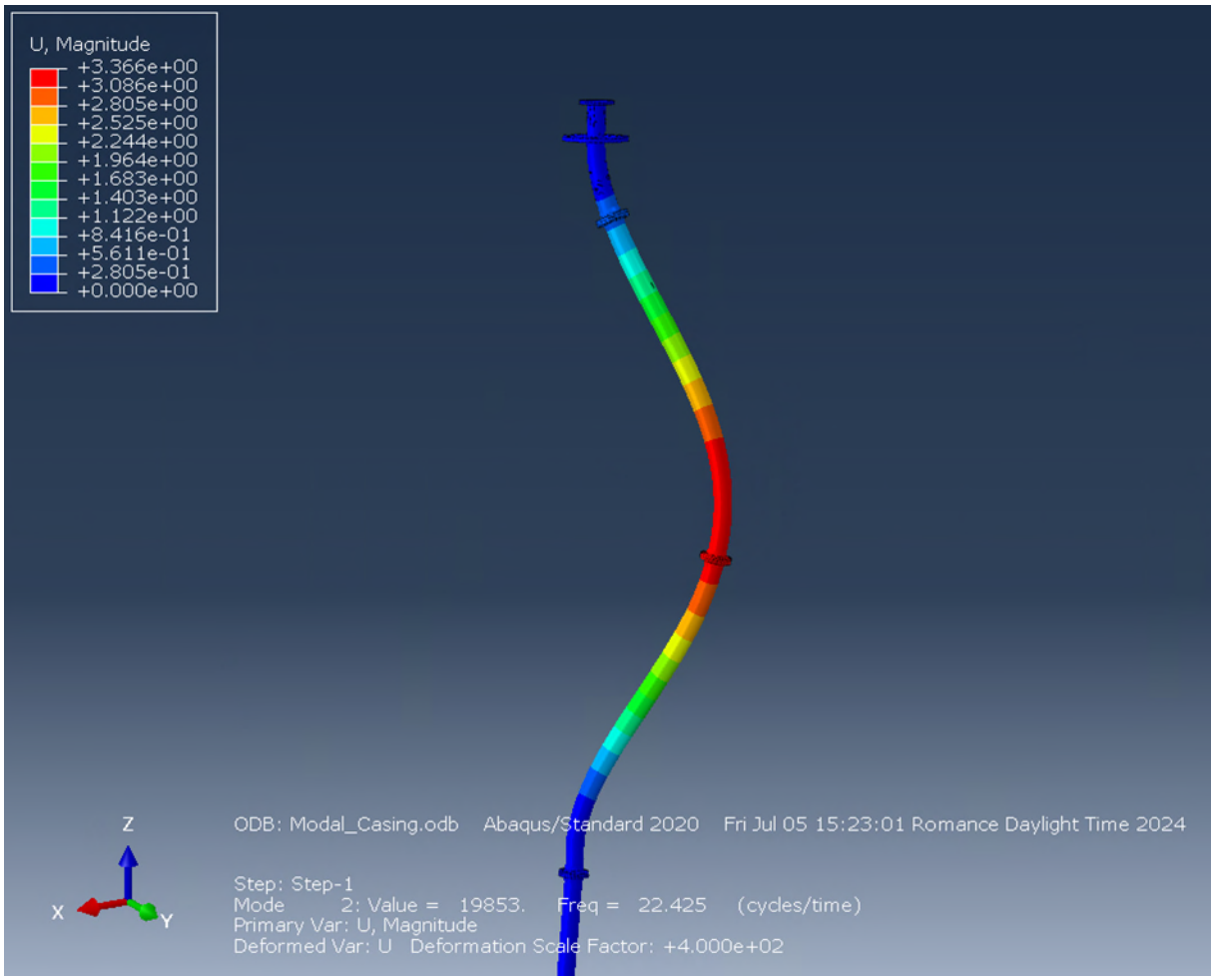


Figure 9: First eigen frequency value for pump casing

The second, third and fourth eigen frequency values of the pump casing were recorded at 25.7 Hz, 26.2 Hz and 26.7 Hz, respectively.

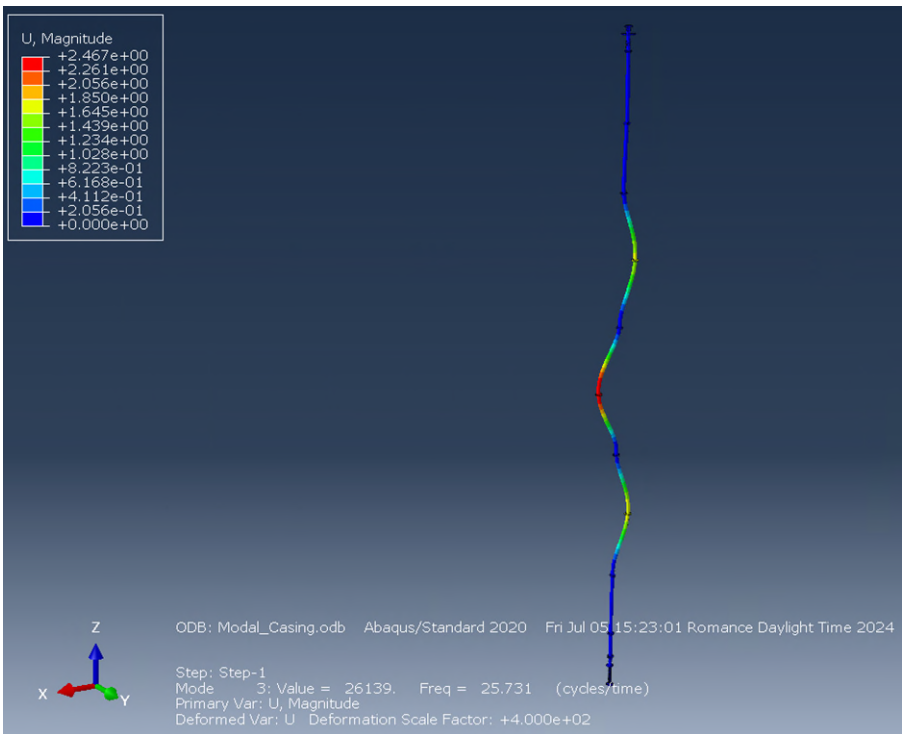


Figure 10: Second eigen frequency value for pump casing

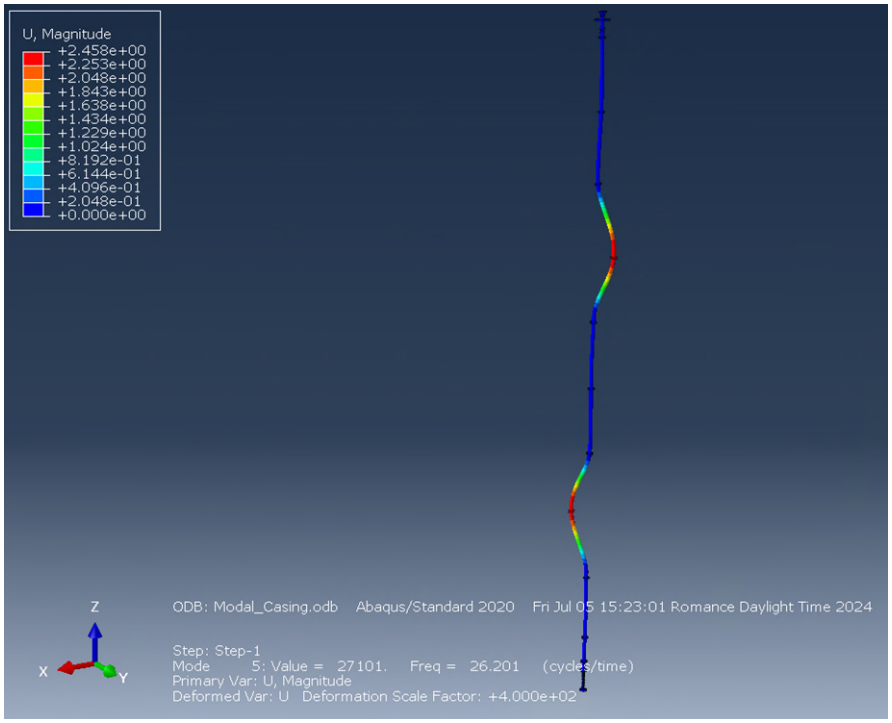


Figure 11: Third eigen frequency value for pump casing

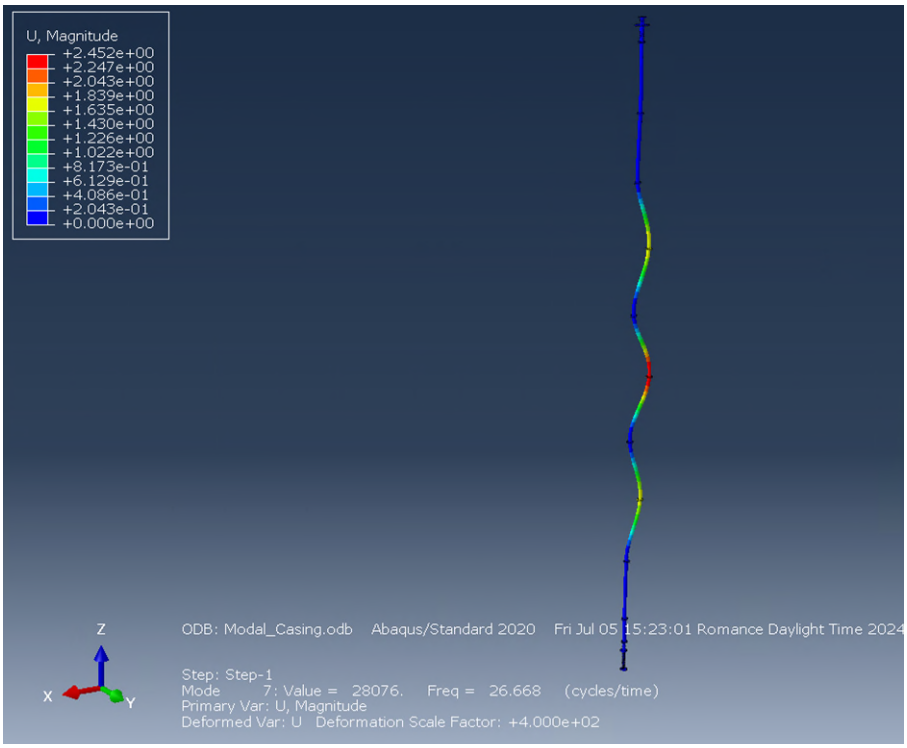


Figure 12: Fourth eigen frequency value for pump casing

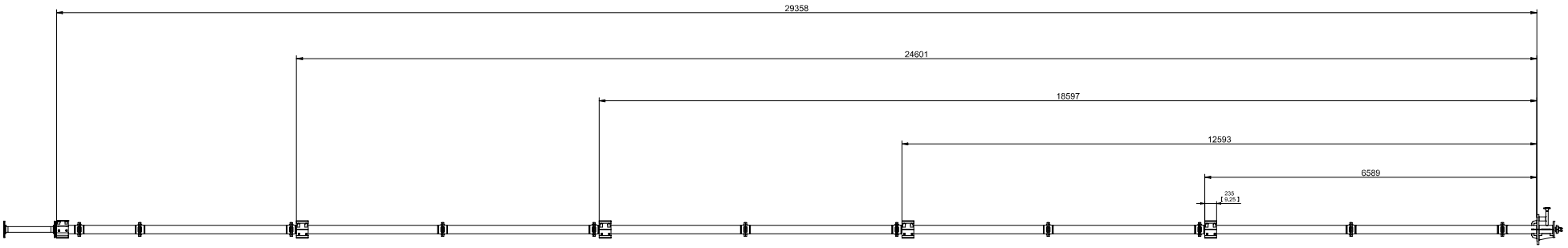
4. Conclusion

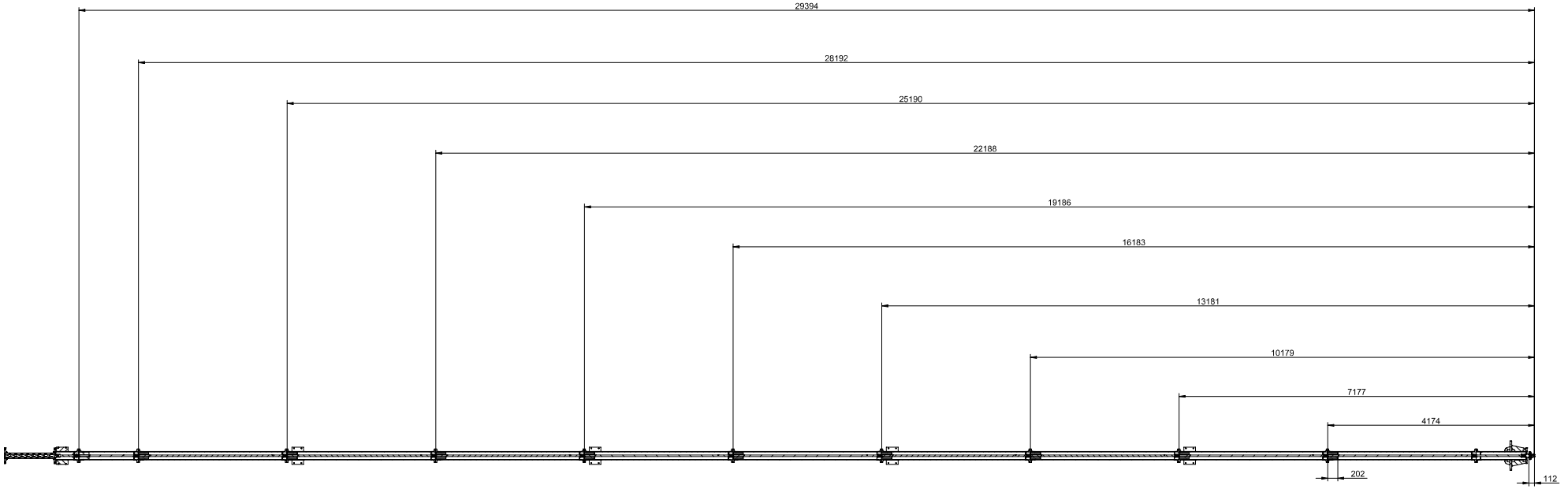
The lower proper frequency of the pump (shaft line or casing) is 11.1 Hz. The rotational speed of the shaft line is 118 rotation/minute that is to say 1.97 Hz.

	Pump Speed	Mode 1	Mode 2	Mode 3	Mode 4
Frequency (Hz)	1.97	11.1	20.6	22.4	25.7
Margin	0	5.6	10.5	11.4	13.0

The proper frequency of the pump is out of the operating range of the pump with a safety margin of **5.6**.

5. Appendices


29358
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