COMMUNICATION SKILLS 2 ASSIGNMENT 1: ANALYSIS OF TRAIN WHEEL



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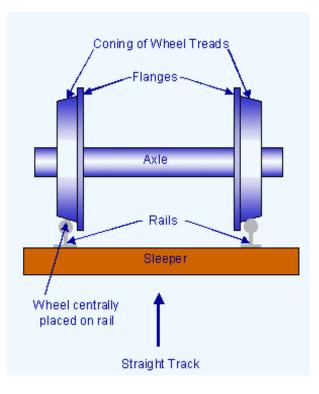
INTRODUCTION

- Introduction
- Problem definition
- Methodology
- Results and discussion
- Conclusions
- Future works

INTRODUCTION

Wheel-rail contact:

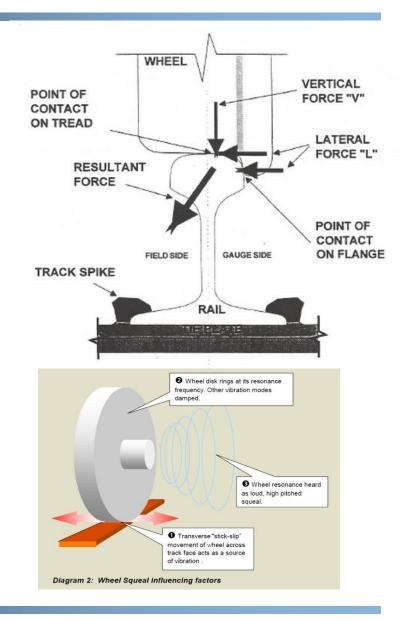
- Consequences:
 - Friction
 - Vibrations
- Flanges: lateral displacements



INTRODUCTION

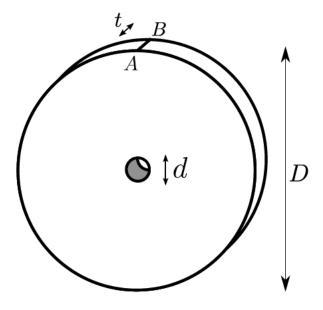
Noises produced:

- Flanging:
 - Intermittent
 - Wide range of frequencies
- Squeal:
 - Very annoying noise
 - Lateral displacements
 - Cause: take curves



PROBLEM DEFINITION

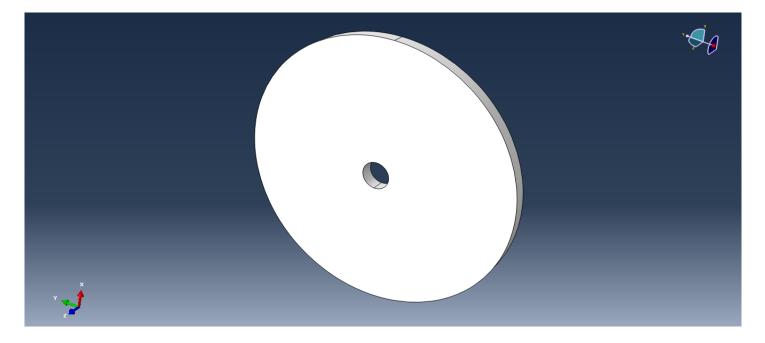
Wheel geometry:



Width	t	[m]	0.05
Internal diameter	d	[m]	0.10
External diameter	D	[m]	1.00
Density	ρ	$[Kg/m^3]$	7800
Yong Modulus	E	[Pa]	210E9
Poisson Ratio	ν	[-]	0.25

STEPS: Software ABAQUS

• **<u>PART</u>**: import geometry



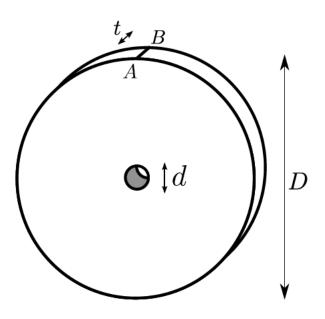
- PROPERTY: create material and assign
- **ASSEMBLY**: create an *instance*

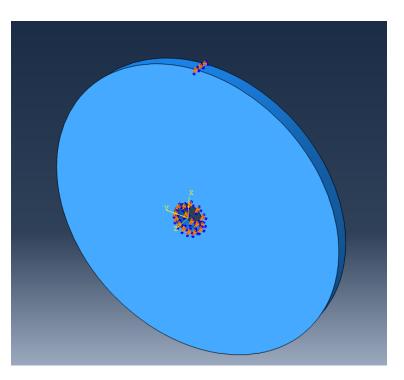
Edit Material	🔶 Edit Material
Name: Material-Rueda	Name: Material-Rueda
Description:	Description:
	Material Behaviors
Material Behaviors	Density
Density Elastic	Elastic
<u>G</u> eneral <u>M</u> echanical <u>T</u> hermal <u>E</u> lectrical/Magnetic <u>O</u> ther	<u>G</u> eneral <u>M</u> echanical <u>T</u> hermal <u>E</u> lectrical/Magnetic <u>O</u> ther
Density	Elastic
Distribution: Uniform 👻 🧔	Type: Isotropic Suboptions
Use temperature-dependent data	Use temperature-dependent data
Number of field variables: 0	Number of field variables: 0
Data	Moduli time scale (for viscoelasticity): Long-term 💽
Mass Density	No compression
1 7800	No tension
	Data
	Young's Poisson's Modulus Ratio
	1 21000000000 0.25
OK	OK

- <u>STEP</u>:
 - Only one step
 - Number of natural frequencies=10

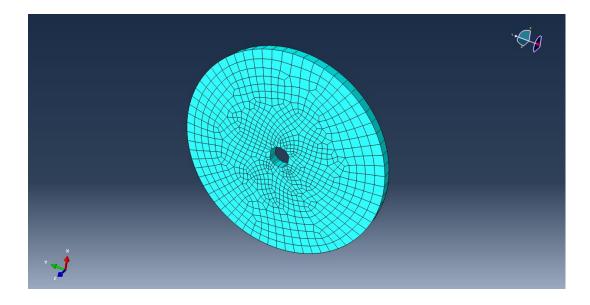
- Create Step	Edit Step
Name: Step-1	Name: Step-1
Insert new step after	Type: Frequency
Initial	Basic Other
	Description: Frecuencias_1
	NIgeom: Off
	Eigensolver: 💿 Lanczos 🔘 Subspace 🔘 AMS
	Number of eigenvalues requested: All in frequency range
	Value: 10
	Frequency shift (cycles/time)**2:
	Minimum frequency of interest (cycles/time):
Procedure type: Linear perturbation 👻	Maximum frequency of interest (cycles/time):
Buckle	Include acoustic-structural coupling where applicable
Frequency	Block size:
Static, Linear perturbation	Maximum number of block Lanczos steps: Default Value:
Steady-state dynamics, Direct Substructure generation	Use SIM-based linear dynamics procedures
	Include residual modes
Continue Cancel	OK

- **LOAD**: boundary conditions
 - Restrict displacements and rotations



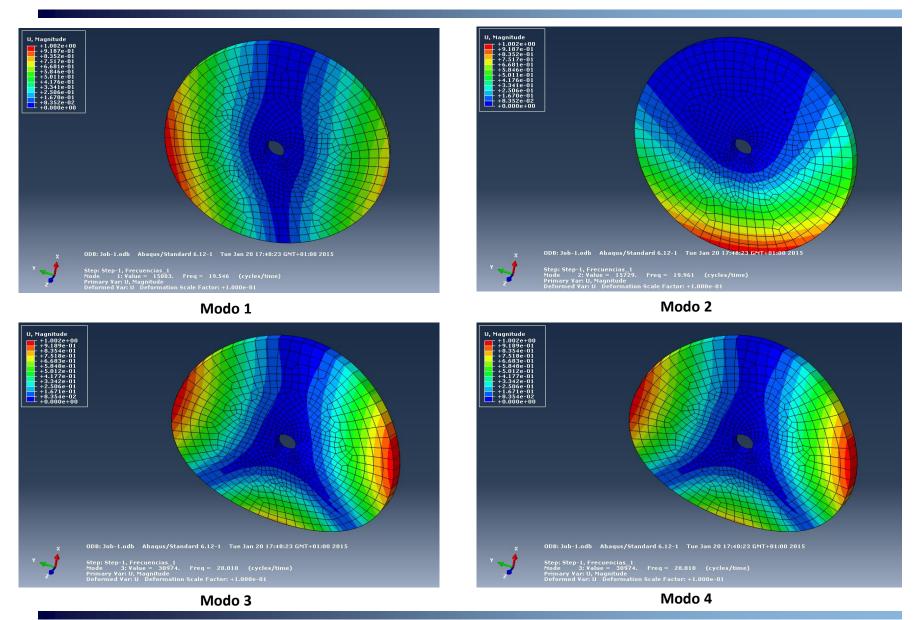


- <u>MESH</u>:
 - Hexaedral elements
 - Global size: 0.05m
- <u>JOB</u>:
 - Submit → Results



• <u>Natural frequencies</u>:

Modo	Frecuencia [Hz]	Modo	Frecuencia [Hz]	
1	19.546	6	77.131	
2	19.961	7	102.28	
3	28.010	8	123.38	
4	37.568	9	129.00	
5	59.266	10	135.47	



Master on Numerical Methods in Engineering

- Rotation frequency:
 - Max. Train speed: 350 km/h

$$f_{rotation} = \frac{97.222}{\pi} = 30.9467 \ [Hz]$$

Mode	Frecuency [Hz]	Speed [km/h]	
1	19.546	221.06	
2	19.961	225.75	
3	28.010	316.78	
4	37.568	424.88	

- Frecuency of the sleepers:
 - Distance between sleepers: 0.6m
 - Max. speed: 350 km/h

$$f_{sleepers} = \frac{97.222}{0.6} = 162.0370 \ [Hz]$$

• Critical speeds:

Mode	Frecuency[Hz]	Speed [km/h]	Mode	Frecuency[Hz]	Speed [km/h]
1	19.546	42,21936	6	77.131	166,603
2	19.961	43,11576	7	102.28	220,9248
3	28.010	60,5016	8	123.38	266,5008
4	37.568	81,14688	9	129.00	278,64
5	59.266	128,0146	10	135.47	292,6152

- Other causes that produce squeal:
- Wheel diameter
- Bend radius of the rail
- Correct alignment of the wheels
- Ambient factors

CONCLUSIONS

- Important wheel deformations
- Risk: rotation frequency (mode 3)
- No risk: sleepers frequency
- Too simplified analysis

FUTURE WORKS

- More complex wheel geometry
- Other rotation-sleepers frequencies
- Wheel diameter changing
- Study wheel defects

Thank you for your attention