



# Metro Trenleri Birincil Süspansiyon Parçalarının Gerilim-Gerinim Gevşeme Hesabının Sonlu Elemanlar Metodu ile Yapılması



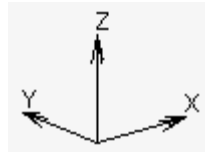
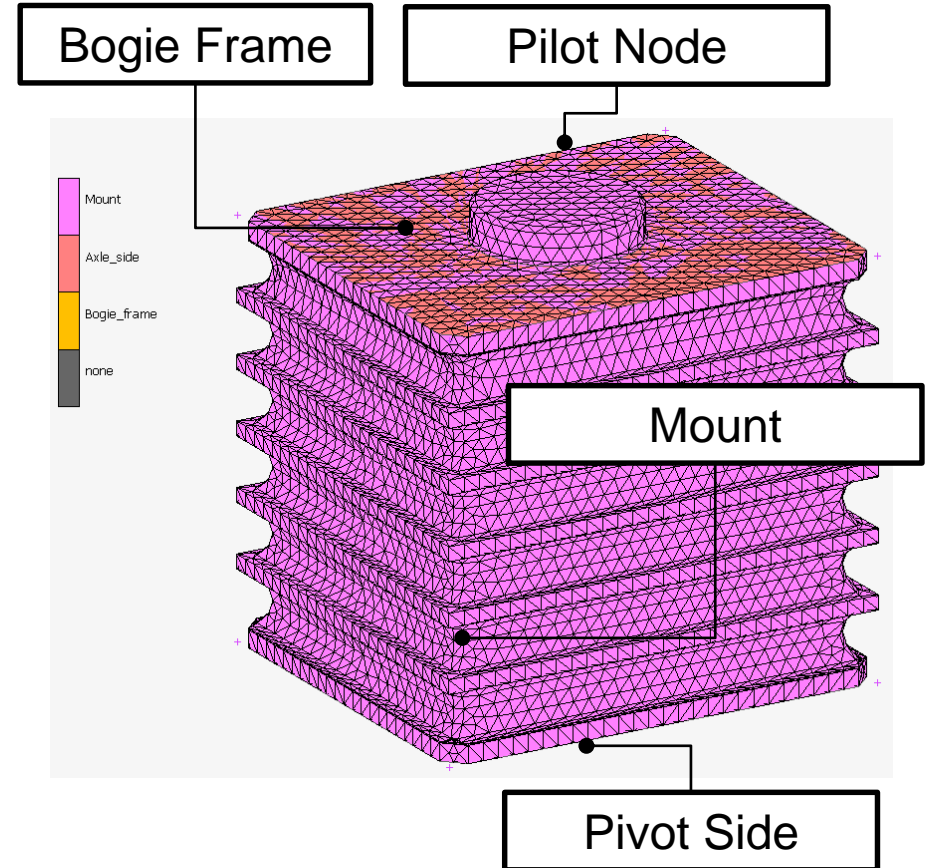
Savaş KAYACI  
Bias Kullanıcı Konferansı 2019





# FEM Model – Setup

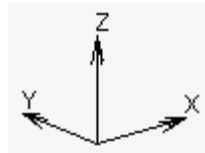
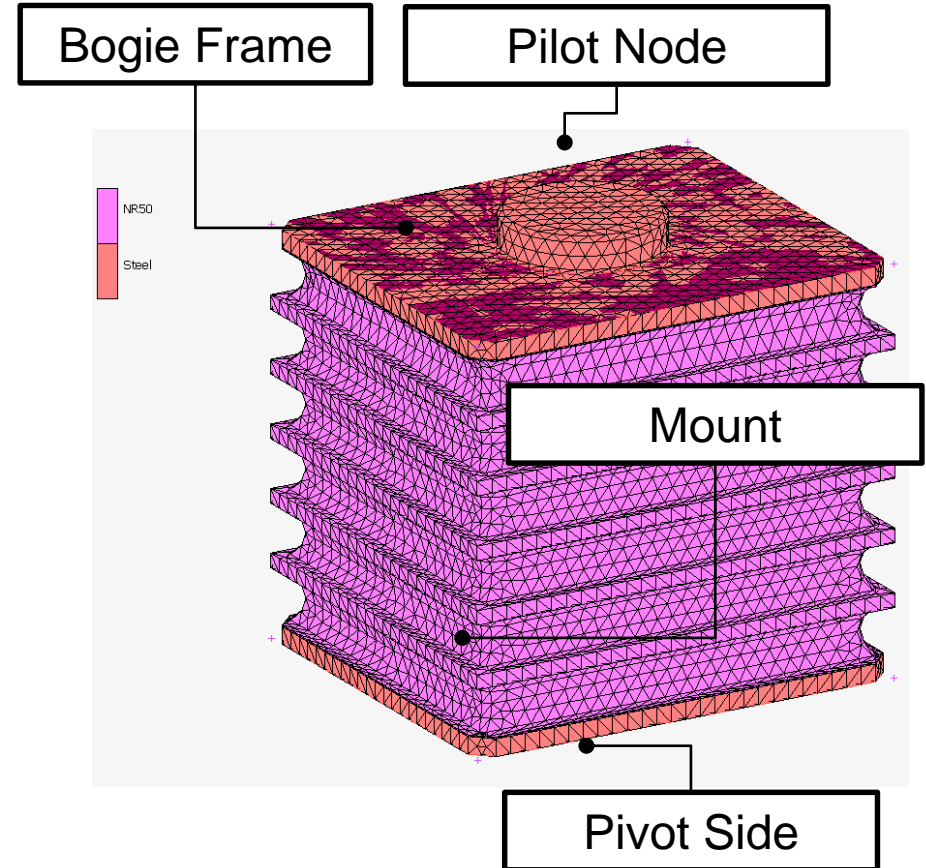
- The meshed parts used Tet4 elements of type 157 and 134,
- Materials available to use:
  - GGG40,
  - NR50,
  - Steel
- Bogie frame, Pivot side surfaces were simulated as rigid surfaces,
- The loads are applied through a pilot node rigidly coupled to the bogie frame surface.





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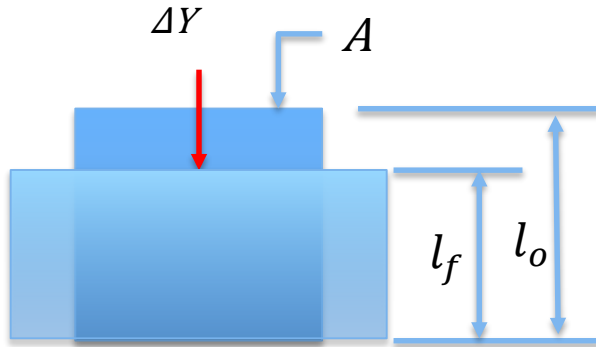


FEA Models utilized for analysis:

- Cer\_ALL\_Voo.mud



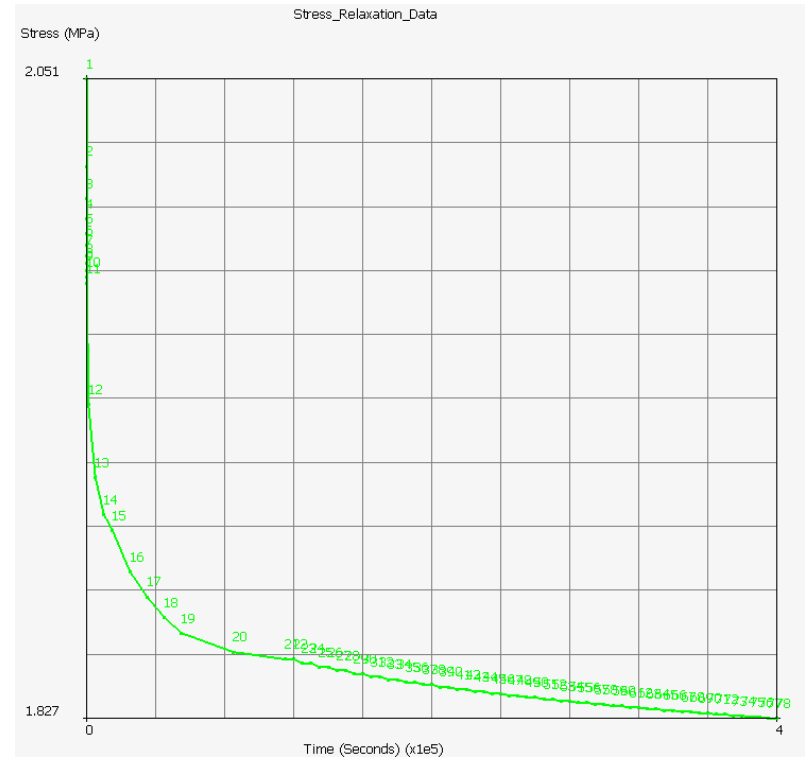
# Viscoelastic Material Data



$\Delta Y$ : Constant deformation to impose a constant compressive strain of 0.1 (10%)

Deformation is kept constant to obtain the corresponding stress change over time domain.

$$\sigma_{c,i} = \frac{F_i}{A}$$





# Viscoelastic Material Data

Material Type | Viscoelasticity Free Energy Relaxation

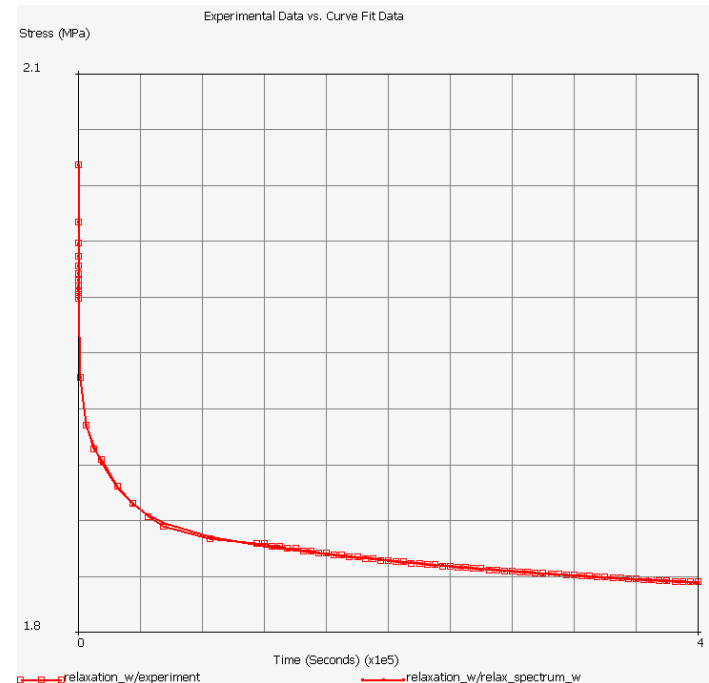
Relaxation

Number Of Terms

Coefficients		
	Linear	Relaxation Time
1	0.0147909	7.09693
2	0.020287	56.5963
3	0.0263229	771.17
4	0.0307269	21246.1
5	0.0232227	292546
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
Long	1.81445	
Short	2.05103	

Compute Create Apply Reset OK

Error



Viscoelasticity free energy relaxation model is used to predict the viscoelastic material properties of rubber material.



# Hyper-elastic Material Data

To obtain this 5-Term Mooney model the following stress-strain data sets are used:

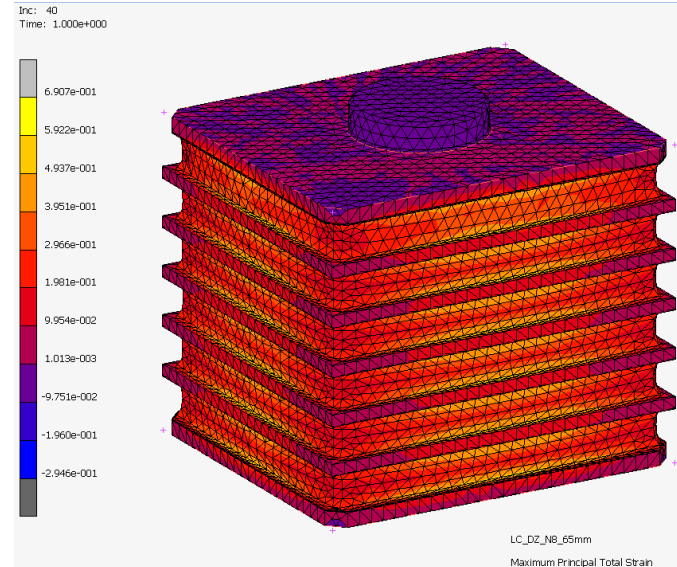
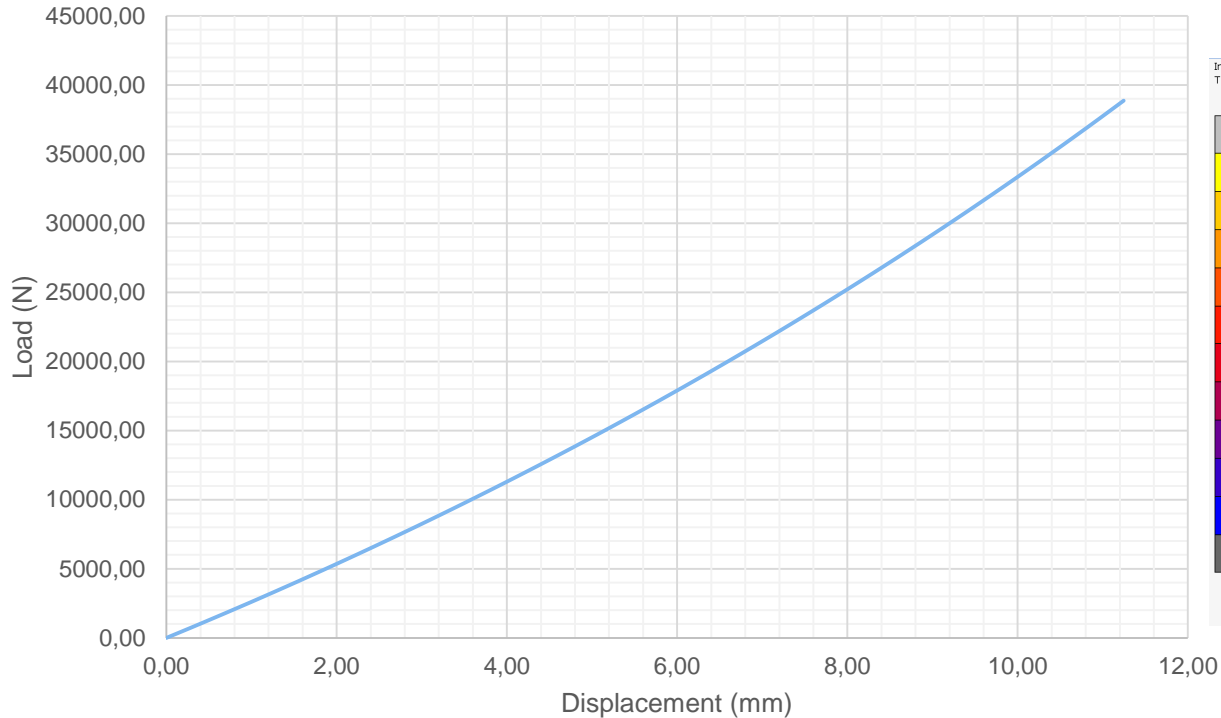
- Compression,
- Simple shear,
- Planar shear,
- Volumetric compression.

Parameter	Value	Action
C10	0.0750741	Table
C01	0.393057	Table
C11	0.00127482	Table
C20	0.00100376	Table
C30	0.00690315	Table



# Linear Rates – Z Direction

Load-Displacement Graph in Z-Direction



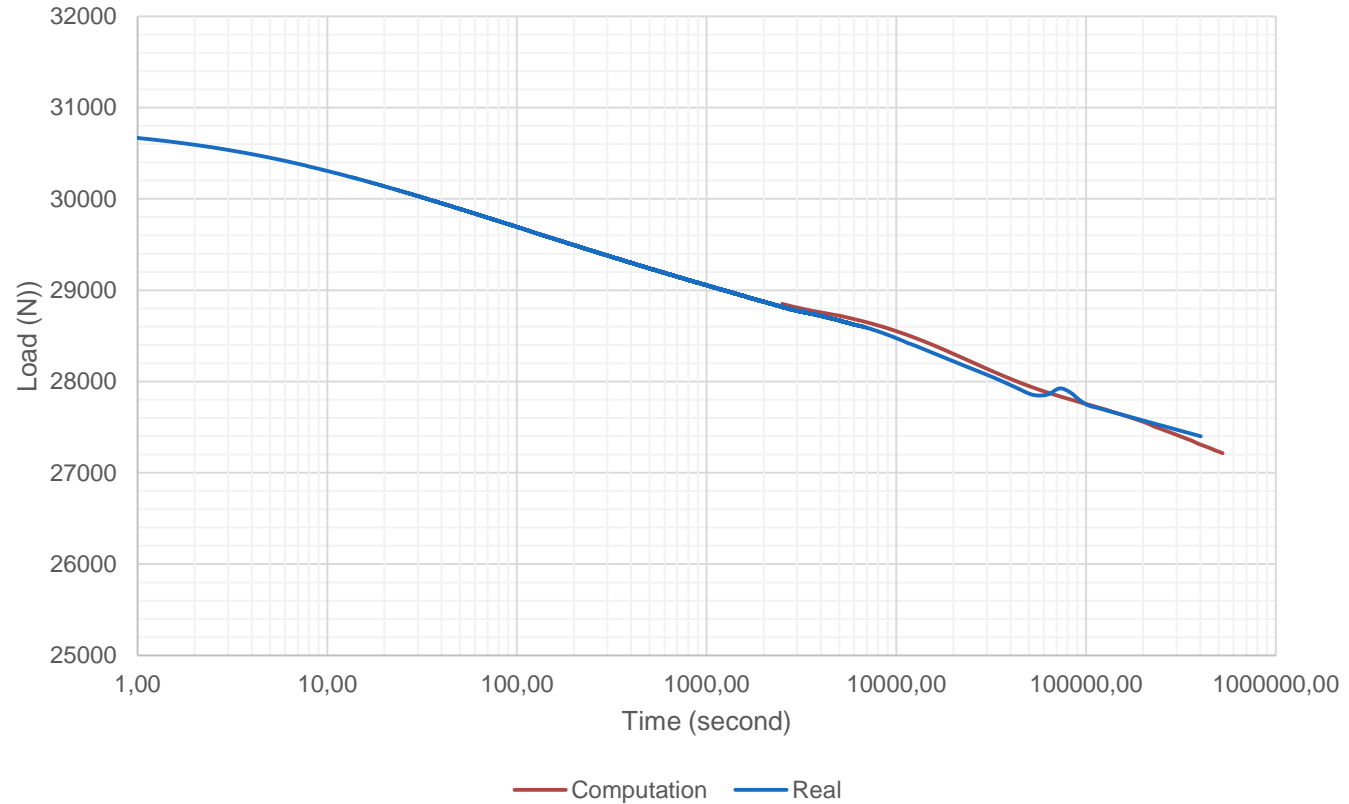
LC\_DZ\_NB\_65mm  
Maximum Principal Total Strain

Chord Limits	Stiffness Calculated (N/mm)	Stiffness Measured (N/mm)
7 – 10 mm	3949.4	3850



# Relaxation Graph at DZ=8.65 mm

Cer Primary Suspension Element Relaxation Graph



Limits (Seconds)	$\Delta F(N)$ Computation	$\Delta F(N)$ Real Test	Difference (%)
1000 - 400000	1752.33	1647.44	6.4





Thanks...

Please contact us:

Address: Demirtaspasa Mah. Tekel Sok. No:2/503 Osmangazi/Bursa-Turkey

Phone: +90 532 203 7125

Email: [savas.kayaci@k-enstitu.com](mailto:savas.kayaci@k-enstitu.com)

URL: [www.k-enstitu.com](http://www.k-enstitu.com)