

Webinar: Introduction to Nastran Mass and Weight Checks

Tommy Board, ATA Engineering June 3rd, 2020

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in ata-engineering

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Why do we check mass/weight?

- Mass checks: the process of verifying that the mass of each component matches a specified value and adjusting the model as needed
- ➢ For dynamic analysis or load cases where acceleration loads are applied, correct mass representation is needed to accurately predict results
- WEIGHTCHECK: the Nastran tool that prints out mass properties for different DOF sets
- WEIGHTCHECK tool can provide insight into other modeling errors such as connections between parts and can help you check units



Checking Mass in Simcenter Femap



- ≻Tools → Mass Properties → Mesh Properties
- ➤Select all elements
- ➢ Review the message window

Check Mass Properties

15456 Element(s) Selected...

	Mass	Center_of_Gravity_in_CSys_0				
		Х	Y	Z		
Structural	3.37261E-7	0.	0.108398	0.		
NonStructural	0.	0.	0.	0.		
Total	3.37261E-7	0.	0.108398	0.		
Inertias_in_CSys_0	Ixx	IYY	Izz	Ixy	Iyz	Izx
About_CSys	8.08073E-9	2.11068E-9	6.07354E-9	0.	0.	0.
About_CG	4.11788E-9	2.11068E-9	2.11068E-9	0.	0.	0.
Total_Length (Line_El	ements_only) =	0.				
Total_Area (Area_El	ements_only) =	0.				
Total_Volume (All_Ele	ments) =	0.00132842				



Checking Mass in Simcenter 3D

You can access this tool from the .fem or the .sim

Element Quality	Node/ Element	More	Show Only	Reverse Face Display	Show Adjacent	Show and Hide	+° A ∛≪ ⊠	More		
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➢ On the Home ribbon, More
 → Solid Properties Check

Select all elements

- Turn on all options
- Review the message area contents:

 Mass, Volume, CG, Inertia, etc.

Note: Don't include CONM1 elements in preprocessor mass checks. CONM1 mass is direction dependent, so NX will automatically exclude these elements from the Solid Properties Check. WEIGHTCHECK will correctly calculate the directional mass.



- Minimal check: List the mass of the entire model. Verify against expected mass.
- Best Practice: List mass by group or component.
 Verify against expected mass and CG of each component.
 - A FEMAP macro has been created that lists mass, CG, etc. based on groups
 - <u>https://www.ata-plmsoftware.com/resources/print-femap-group-summary-to-excel/</u>
- ≻Different ways to do mass matching
 - ➤ Adjust density of the material
 - ➤Add non-structural mass to a mesh



Nastran WEIGHTCHECK: How to Set It Up in Femap

In Femap, weight check is available in the Analysis Set Manager

Analysis Set : 1FFM Solver : Simcenter Nastran Type : Normal Modes/Eigenvalue Integrated Solver : Simcenter Nastran	Analyze Analyze Multiple				
· Options	Export	NASTRAN Model Check			>
	Active	Weight Check		Ground Check	
	Preview Input	DOF SET G	F	DOF SET	F
Model/Buckling		ПN	A	□ N	
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	Edit				
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How to Set Up WEIGHTCHECK in Simcenter 3D

In Simcenter, weight check is available in the Solution window

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Solution				^			
Name	Solution 1						
Solver	Simcenter Na	Simcenter Nastran					
Analysis Type	Structural			•			
2D Solid Option	None			•			
Solution Type	SOL 103 Real	Eigenvalues		•			
Automatically	/ Create Step or	r Subcase					
SOL 103 Real E	igenvalues			Preview			
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		Global Glue Parameters	None 👻	æ			
		Eigenvalue Method	Lanczos	•			
		Lanczos Data	None 👻	e			
		Residual Vectors	None 👻	æ			
		Mode Selection	None 👻	æ			
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		Monitor Point Type to Output	Default	•			
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WEIGHTCHECK reports the mass properties of a part, including mass moment of inertia and center of mass WEIGHTCHECK (PRINT, SET= (ALL), GRID=1481786, CGI=NO, WEIGHT) = YES Can choose Print weightcheck results in results to the .f06 file weight or Requests CG and mass units Check at least the G, inertia data (if NO, N, and A sets, and this data is only make sure the mass is printed for G set) the same across sets Weightcheck depends on a reference location

See next slide for more information about sets

If no grid is specified, origin of the Nastran basic CSYS is used

If the origin is far from the center of the mesh, specify a different grid ID near the CG of the assembly



Response of a FEM defined in terms of DOF
 6 DOF per GRID, 1 DOF per SPOINT/EPOINT

≻All DOF in Nastran placed in sets

- ➤G-set: All DOF (except EPOINTs)
- ≻ M-set: All dependent DOF (RBE2, RBE3, MPC)
- > N-set: G-set minus M-set (all independent DOF)
- ➤S-set: All restrained DOF (user and AUTOSPC)
- ➤ F-set: All free DOF (N-set minus S-set)
- ➤O-set: Interior or "Omitted" DOF
- ➤ A-set: Solution DOF (F-set minus O-set)
- ➤ Q-set: Modal DOF
- ➢ B-set: Physical DOF held fixed in CMS modal solution
- ➤C-set: Physical DOF free to vibrate in CMS modal solution



Sample Output from WEIGHTCHECK



model prefers to spin about)

13

How do the CG coordinates get calculated?

 \geq Blue matrix in top right is equivalent to this matrix:

$$n \begin{bmatrix} 0 & Z_{cg} & -Y_{cg} \\ -Z_{cg} & 0 & X_{cg} \\ Y_{cg} & -X_{cg} & 0 \end{bmatrix}$$

➢ If you divide blue matrix by mass, you will get the CG coordinates

What to Look for in WEIGHTCHECK Output

- \succ Check if the mass matches your expectations
 - This will help you check if all material properties are correct (both values and units!)
 - Compare to mass measured by pre-processor
 - Compare to mass estimated based on CAD volume and material density
 - Check whether you are using WTMASS parameter is WEIGHTCHECK printing out masses or weights, and does this match your expectations?
- If your deck contains DMIG mass matrices, the mass will not match the pre-processor
 - You should still compare mass to pre-processor to verify it matches expectations
- Check if the mass is the same between sets
 - Changes in mass between sets are not common but typically indicate a modeling error
 - What could cause this? See next slide
 - What to do if the mass changes between sets? Review other standard model checks, including:
 - Check what is being restrained
 - Do ground checks
 - Review all AUTOSPCs

Examples of Masses Changing Across <u>Different DOF Sets</u>

➤Mass on boundary conditions

➢ i.e. lumped mass on an SPC

➤Mass regions that have been AUTOSPCed

≻Model grounding

≻Lumped mass in the O-set

 \succ i.e. there is a model reduction

≻Example Scenario:

- One component of a large assembly was replaced with a lumped mass
- Original model had small lumped mass elements that were not reconnected
- Nastran AUTOSPCed the disconnected elements
- When the AUTOSPC's were added (in between the N set check and A set check), the model mass changed

An Alternative to Weight Checks

- ➢If acceleration loads are applied, look at the net reaction forces
- Compare the sum of the reaction forces to the FEM total mass times the applied acceleration
 - ➤ You should get F=ma
 - \succ If not, there is an issue with the model setup
- Nastran WEIGHTCHECK tool is preferred method, but checking the reaction forces can be a good additional check and can be used for other solvers like ANSYS

Questions?

Submit questions in the chat or unmute yourself now

Zoom Application

Web Interface

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