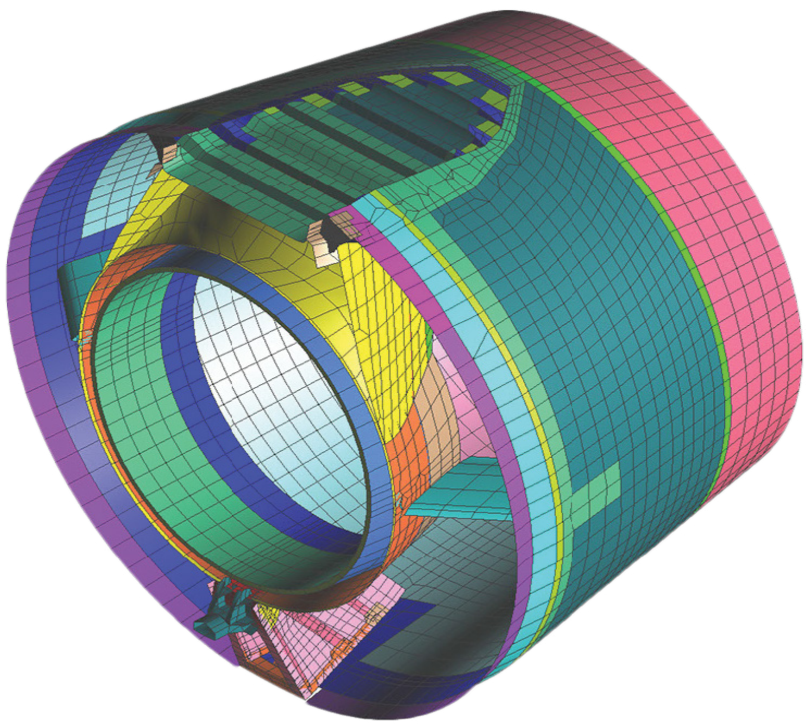
MSC Nastran™ 2019 Feature Pack 1



HEXAGON | MSC Software

Welcome to MSC Nastran 2019 Feature Pack 1!

With more than 50 years of industry application, MSC Nastran has widely been used by various industries to solve linear static, dynamic, nonlinear, fatigue and many other engineering problems. MSC Nastran 2019 Feature Pack 1 continues the evolution of better CAE design processes through the implementation of faster, more accurate, real coupled modes calculation, streamlined buckling analysis for mildly nonlinearities present in the structure, all combined with more efficient solver methods. Some highlights about this new release are described in this document.

Real Coupled Modes Computation

In order to compute the coupled modes of a heavy fluid-structure problem, a computationally expensive complex eigenvalue solution (SOL 107) was required because the matrix problem posed is asymmetric. Real coupled mode feature supports computation of fluid and structure modes as a coupled system with a real Eigen solver for SOL103.

The coupled modes feature can now include Structural and Fluid Damping (with PARAM, G and GFL cards, G value in material cards or SDAMP card) for modal frequency (SOL 111) and transient (SOL 112) solutions.

To complement real coupled modes, in MSC Nastran 2019 Feature Pack 1, we have added hydrostatic loading capability.Fluids apply pressure loading to the sides on containment vessels and the new Hydrostatic-loading feature will allow MSC Nastran to simplify this procedure with two new load cards HYDROC and HYDROS. This eliminates the need for extensive hand-calculations and simplify the MSC Nastran set up for Hydrostatic loading.

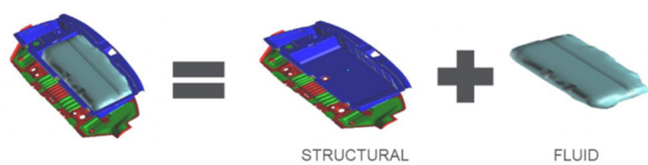


Figure 1 "Truly" Coupled Mode Computation

Elastic Force Output

In dynamic analyses, forces such as elastic, inertia and damping are involved. Elastic Forces is specifically associated with the structural stiffness of the FEM model.

Elastic forces can now be requested for every frequency or time step for user specified set of grid points. A new case control command ELAFORCE is introduced to request it in print, punch, plot (op2/h5) format in Frequency Response (SOL 108/111/200), Transient Response (SOL 109/112/200), Flutter (SOL 146) and Non-linear Static (SOL400). We also support elastic forces data recovery in CMS recovery for external Superelement. Output will be in f06, punch and HDF5 format.

```
                        PRINT                        All
ELAFORCES ([ SORT1 ],[ PUNCH ],[ REAL/IMAG ])={  N   }
             SORT2      PLOT      PHASE          NONE
```

Figure 2 ELastic Force Request in MSC Nastran 2019 FP1

Composites

Majority of aerospace structures are subjected to random dynamics. There was a gap in MSC Nastran's HDF5 capability such that the results of random response were not written to HDF5 Previously, the output was limited to punch files by XYPLOT only. This enhancement allows users to output random response for composite ply stress and strain for frequency response analysis to HDF5. PSDF, CRMS, ATOC and other responses for each ply of composite element can be output to HDF5. RCROSS (Cross-Power Spectral Density and Cross-Correlation Function Output Request) results output is also supported

Aerospace structures are increasingly using composites in the primary and secondary structure. This enhancement allows using HASHIN composite failure theory in linear solutions, which is used by many Aerospace companies to study composite failure. HASHIN failure criterion is useful because it distinguishes between fiber failure and matrix failure. At each integration point, MSC Nastran calculates the failure index (FI) for each mode.

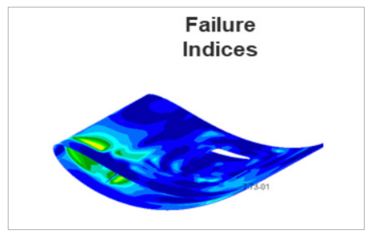


Figure 3 Hashin Failure Crtieria Indices

Contact Enhancements

In linear contact capability for quasi-linear analysis, the establishment of contact constraints and distribution of contact forces are applied on the initial undeformed geometry. This linear contact capability is supported for node-to-segment contact in MSC Nastran 2019. In MSC Nastran 2019 Feature Pack 1 release, the linear contact feature is extended for segment-to-segment contact.

MSC Nastran now allows users to define contact using surface definition for the Contact Analysis Capability. Surface definition in contact gives exact description of the contact area and hence enhances the avoidance of misleading errors in the contact analysis. Surface Contact definition are defined using new BULK DATA entries, namely 'BCSURF' and 'BCGRID'. These entries provide a concise method and better control to define contact areas based on element faces and grid points.

- BCSURF allows to create DEFORMABLE as well as RIGID 3D and 2D contact surfaces.
- BCGRID allows to define the contact area based on grid points.

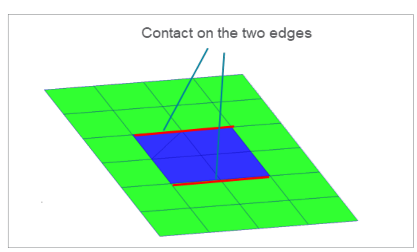


Figure 4 New Surface Contact based on Grids Approach

Linear Buckling (Perturbation) Analysis in SOL 400

This feature allows the user to request a linear buckling analysis following a perturbed nonlinear analysis in a similar fashion to other analysis types like normal modes, frequency response, etc. The buckling equation to be solved is $[Kt + \lambda Kd] \{\Phi\} = 0$ where is the perturbed (or tangential) stiffness matrix computed in the nonlinear step and is the differential and follower stiffness computed in the nonlinear step. It should be noted that is also contained in both traditional and advanced nonlinear elements is supported.

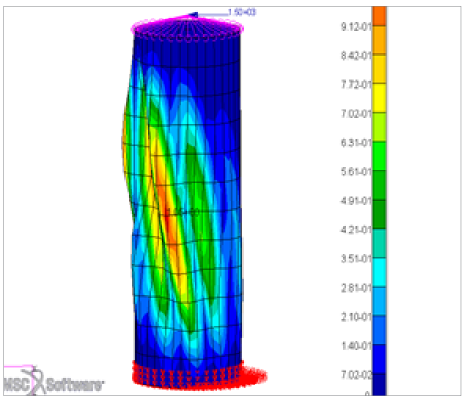


Figure 5 linear buckling analysis following a perturbed nonlinear static analysis, first mode Pcr=1668

High Performance Computing

- Support in FASTFR and MPYAD Modules with GPU
  - The biggest expense in FASTFR module is the computation of “matrix C”, which is performed by a single zgemm/dzgemm kernel, so speeding up FASTFR is essentially the same as speeding up MPYAD for dense complex matrices.
  - It’s aimed at improving performance of jobs involving FASTFR and MPYAD Modules by offloading the zgemm/dzgemm kernels to GPU.
- ACMS and SOL 111 Performance Improvements for Automotive NVH Phase 2
  - Support residual vector augmentation for the fluid eigen solution.
  - Reduce memory requirements for structural damping (K4) matrix reduction.
  - Provide adaptive capability for DMP memory allocation.

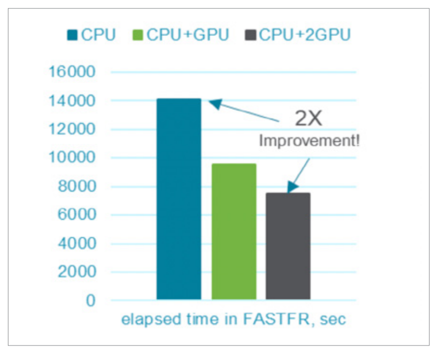


Chart representing performance improvements after using the new FASTFR and MPYAD module with GPU