Overview of MSC/DYNA Versions 2 and 3

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MSC/DYNA is MSC's explicit transient dynamic code designed for structural applications like automotive crash, ship collision and metal forming. It compliments the other explicit codes MSC/PISCES and MSC/DYTRAN which are intended for applications involving fluid/structure interaction and extreme deformations.

MSC/DYNA Version 2 is the latest version of the code, currently available on a range of popular computers. It is a significant enhancement over Version 1 in terms of speed, capability and ease of use. MSC/DYNA Version 3 will further enhance the code. This paper presents an overview of the new capabilities in Version 2 and the enhancements that users can expect in Version 3.

MSC/DYNA VERSION 2 CAPABILITIES

Solution

New, Faster Single Surface Contact Algorithm: This feature is used to model a surface contacting itself, such as buckling sheetmetal. An entirely new algorithm has been implemented that is much faster. The following times were obtained for a typical analysis of the crushing of a sheet metal box beam:

Old algorithm:	1187s	(Cray-XMP)
New algorithm:	288s	

Vectorization of RHS Calculations: The calculations involving the assembly of the force vector have been vectorized. This is completely transparent to the user, but can offer significant cpu savings.

Energy Balance: MSC/DYNA independently calculates the following energies:

Kinetic energy:	due to motion of the model.
Strain energy:	due to elastic and plastic straining.
Friction energy:	"lost" in frictional sliding of contact surfaces and rigid walls.
Hourglass energy:	due to hourglassing of elements.
Numerical energy:	due to numerical algorithms like the contact surfaces.

These energies can be used to monitor the quality of a calculation.

Global Damping: Damping can be applied to the whole model to damp out dynamic oscillations in a quasi-static analysis.

Vectorized Springs and Dampers: All the spring and damper elements are now vectorized.

Elements

Improvements to the Belytschko-Schwer Beam: The beam element now allows the specification of the plastic modulus and performs more accurately when a plastic hinge has formed.

CELAS1, CELAS2, CDAMP1 and CDAMP2 Springs and Dampers: The scalar spring and damper elements are available in addition to the CSPR and CVISC elements. The springs can be elastic, nonlinear-elastic, elastic-plastic, nonlinear or user defined; the dampers linear or nonlinear. They can also connect rotational degrees of freedom. These elements work in the same way as MSC/NASTRAN.

User Defined Spring and Damper Routines: Users can write their own subroutines to define the characteristics of springs and dampers.

Separate Control of Shell Hourglass Coefficients: The three hourglass modes of the CQUAD4 shell elements can now be individually controlled.

Material Models

Multi-layer Composites: DYMAT22 allows multilayer composites to be modelled including a variety of failure criteria.

Cowper-Symond's Strain Rate Enhancement: The Cowper-Symond's law or the enhancement of yield stress due to strain rate has been added to DYMAT24.

Constraints

Frictional Rigid Walls: Rigid wall constraints can now be frictionless, have infinite friction or have specified low and high speed coefficients of friction.

Loading

Follower Forces: The follower forces (FORCE1 and FORCE2) work in the same way as MSC/NASTRAN.

Moment Loading: Fixed direction concentration moments (MOMENT), or follower moments (MOMENT1, MOMENT2) can be specified. Again they are compatible with MSC/NASTRAN.

Enforced Motion of Rigid Bodies: The motion of the center of gravity of a rigid body can be specified. This is useful for modelling the motion of the punch in sheet stamping analyses.

Input

FMS and Executive Control: The File Management and Executive Control Sections make the MSC/DYNA input file compatible with MSC/NASTRAN Version 66.

Output

Output to MSC/XL: MSC/DYNA can write MSC/XL databases directly.

Cross Section Forces: Sums the forces passing through an arbitrary cross section of the model defined as a sequence of solid, shell and/or beam elements.

Additional Output: The following additional information can now be output for postprocessing.

- Forces and moments in Belytschko-Schwer beam and rod elements.
- Contact forces.
- Element strain energy.
- Property strain energy.
- Shell thickness.
- Rigid wall forces.
- Element critical timesteps.

These are additional to the displacements, velocities, accelerations, stresses and strains previously available.

User Interface

Analyses Termination: The analyses will write a restart file and terminate if:

- the cpu time limit is exceeded
- the energy balance is worse than a specified value
- the numerical energy is worse than a specified value
- the hourglass energy is worse than a specified value
- the machine roundoff is worse than a specified value

This prevents excessive cpu time being wasted on incorrect analyses.

Cpu Time Estimation: At the end of a data check, MSC/DYNA estimates the cpu time and memory required for the analysis.

Improved Error Checking: Many additional errors and warnings have been added to the code.

Utilities

The utility programs DYPAT and DYSTAB and the database access routines DYLIB have been enhanced to process all the new types of output. A digital filter has also been added to DYLIB and DYPAT.

Availability

MSC/DYNA is currently available on the following computers/operating systems:

- Cray XMP/YMP - Unicos
- Convex C1/C2 - Unix
- DEC VAX - VMS
- IBM - MVS/XA (Vector and Scalar machines)
- DEC DECstation - Ultrix
- SGI - Irix

The following additional ports will be available shortly:

- Sun Sparcstation - SunOS
- IBM RS6000 - AIX
- Apollo DN10000 - Unix

MSC/DYNA VERSION 3 - A PREVIEW

The development of MSC/DYNA Version 3 is well underway and should be shipped to customers starting in the summer of 1991. Although the final list of capabilities and enhancements is far from fixed, the following additional capability should be available:

Improved Composites: The composite capability will be improved and made fully compatible with MSC/NASTRAN using the PCOMP entry. It will be possible to have different material properties in the different laminates.

High Explosive Materials: The JWL and Sack-Tuesday equations of state will allow the modelling of the detonation of high explosives and its effect on surrounding structure.

Rubber Materials: A nonlinear elastic material model will allow rubber to be modelled.

Johnson-Cook Material Model: The Johnson-Cook model for rate and temperature dependent plasticity will be available. This will incorporate the Johnson-Cook failure model.

Linear Polynominal and Tabulated Equation of State: These equations of state allows more sophisticated modelling of crushable materials than is possible with DYMAT5.

Orthotropic Crushable Plasticity Material Model: This material can be used to model crushable materials which exhibit orthotropic behavior, like honeycombs.

Temperature Dependent Plasticity Material Model: The material properties can vary with temperature.

Temperature Input: MSC/DYNA will be able to read transient temperature data.

Improved FRC File: Any type of data can be stored in the FRC file, giving MSC/DYNA three independent postprocessing databases.

Binary File Reorganization: The RES, HIS and FRC files will be reorganized so they use less disk space for some problems.

Forces at Constraints: The forces at constraints, like SPCs and grids with enforced motion, can be output.

Rotational dof on RBE2: Rotational degrees of freedom can be used on RBE2s.

Piecewise Plasticity for Beams: The piecewise linear plasticity model including rate effects, DYMAT24, can be used with Hughes-Liu beam elements, allowing strain softening and more complex material behavior to be modelled.

Non-Reflecting Boundaries: Non-reflecting boundaries prevent the reflection of stress waves at boundaries, allowing semi-infinite regions to be modelled more accurately.

Auto-reverse of Contact Surfaces: MSC/DYNA will automatically reverse the segments in single surface contact to ensure that the direction of the z axis of adjacent segments is the same. This will ease the modelling of complex contact surfaces.

Additional enhancements will also be available as part of MSC's commitment to respond to the needs of our customers.