R14.2.0 Release Notes

June 5, 2025

1 Release notes revision

This file constitutes revision 0 of the release notes for Ansys LS-DYNA® version R14.2.0.

2 License

The string "REVISION 14" must appear in the license file to run version R14.2.0. Please contact your distributor or your Ansys sales representative if you need to have your license updated.

3 Documentation

The R14.0 User's Manuals provide documentation for R14.2.0. To download these manuals, go to https://lsdyna.ansys.com/manuals/. For features mentioned in these notes missing from the R14.0 User's Manuals, please refer to the DRAFT User's Manuals at https://lsdyna.ansys.com/manuals/. Please note that not all features in the DRAFT User's Manuals are available in version R14.2.0.

4 Notes

The remainder of this file briefly describes new features, enhancements, and bug fixes in version R14.2.0. Other recent releases may also include some of these updates.

We arranged the items by category. Understand that, in many cases, a particular item may pertain to more than one category. In the interest of brevity, we list each item only once, under a single category.

5 New

5.1 MPP

1. Added keyword ***CONTROL_MPP_IO_NOTIEDIO** to invoke using memory instead of IO for storing the tied_nodes temp files to avoid problems on distributed file systems. The equivalent pfile command is `general { notiedio }`.

6 Improvements and Enhancements

6.1 Acoustics, NVH, and Frequency Domain

1. For ***FREQUENCY_DOMAIN_ACOUSTIC_BEM_ATV**, added output of d3atv when the velocity is defined on nodes (NOEL = 1). Previously, **d3atv** was supported only when velocity is defined on elements (NOEL = 0).

2. Added an mcf-only option to compute the mcf file without writing d3ssd. Setting BINARY = 0 in ***DATABASE_FREQUENCY_BINARY_D3SSD** enables this option. Before this enhancement, obtaining the mcf file required also writing the d3ssd file. The mcf file is an ASCII file containing modal coefficients for SSD, prepared for nCode Designlife.

6.2 Adaptivity

1. Added flag ADPD3P to Card 1b of ***CONTROL_ADAPTIVE** to control

output for 3D *r*-adaptivity.

2. Added support for ADPOPT in ***PART** when INMEMORY of ***CONTROL_ADAPTIVE** is on. A part with ADPOPT not set or set as zero will be skipped for in-core adaptivity. This behavior is consistent with out-of-core adaptivity.

6.3 Airbags

1. Support unlimited gas species for ***AIRBAG_PARTICLE**. Internally, there had been a limit of 40 species.

2. Added keyword option TIME to ***AIRBAG_PARTICLE** to control the airbag's start and end time. All the time-dependent curves used by this airbag are automatically shifted by the start time.

3. Added IOUT to ***AIRBAG_REFERENCE_GEOMETRY** and ***AIRBAG_SHELL_REFERENCE_GEOMETRY** to enable outputting the current reference node coordinates to a keyword file.

6.4 Boundary Cards

1. Support IDOF = -4 and -8 on ***BOUNDARY_PRESCRIBED_MOTION** for rigid bodies if |CMO| = 2 on ***MAT_020** or ***CONSTRAINED_NODAL_RIGID_BODY**.

6.5 CESE Compressible Fluid Solver

1. Made the chemically-reacting flow solvers faster and more robust. These improvements also make using much larger CFL numbers in the time step control possible, depending upon the quality of the CESE computational mesh. Most importantly, we replaced the internal nonlinear temperature solvers with more robust versions. These new methods correct many cases where errors such as the following were encountered:

```
Error 150209 (CHEM+209)
   Chemistry EOS nonlinear temperature solver failed to converge.
   Error code = 50 Last iterate temperature = 0.96106E+03
```

6.6 Constraint Cards

1. Added support for ***CONSTRAINED_NODE_INTERPOLATION** in MPP. The MPP version follows the generic definition of nodal displacement interpolation constraints, where the displacements of interpolation nodes depend on the nodes controlling the interpolation. This new development does not apply to IGA or generalized elements. Image parts in RVE analysis (see ***RVE_ANALYSIS_FEM**) automatically and internally use this keyword.

2. Setting |CMO| = 2 on ***CONSTRAINED_NODAL_RIGID_BODY** enables applying the constraints or prescribed motion (***BOUNDARY_PRESCRIBED_MOTION**) of the rigid body about a specified coordinate.

3. Added optional force-based failure criterion (see Card 7) to ***CONSTRAINED_INTERPOLATION_SPOTWELD** (SPR3). The force-based criterion simplifies the transition from ***MAT_100** as an alternative to damage driven by plastic displacements. The same update applies to ***MAT_265**.

4. Made changes for using functions in SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD** with MODEL > 10):

    - Added five new arguments: initial yield stresses of both partners, resultant velocity, and two failure terms (normal and shear).
    - Support more materials: 3, 36, 81, 133, 187, 224, 243, 251, and 324.
    - Enabled more parameters to be defined as functions with MODEL > 30. The same change applies to ***MAT_265** (***MAT_CONSTRAINED_SPR3**).

5. Added new search method for SPR2 and SPR3 invoked by flag SPRSRCH on ***CONTROL_CONSTRAINED**. SPRSRCH = 1 invokes including not only the nodes inside the search radius but also all nodes from elements inside the search radius. In addition, this option invokes a different search algorithm from SPRSRCH = 0 when solid element parts are involved: nodes on the surface facing the SPR connector are detected, leading to automatically finding enough nodes.

6. Add the TITLE keyword option to ***CONSTRAINED_INTERPOLATION_SPOTWELD** and ***CONSTRAINED_SPR2**. This title is used as the part title of the visualization beams.

7. Added an SPR3 with a strongly object formulation (see MODEL = 3 on ***CONSTRAINED_INTERPOLATION_SPOTWELD**).

8. Added option STIFF2 < 0 to ***CONSTRAINED_INTERPOLATION_SPOTWELD** (SPR3). For this case, |STIFF2| is a load curve ID for shear stiffness as a function of load angle. This curve allows a better fit for the elastic-mixed-mode response.

9. Add damping option DAMP to ***CONSTRAINED_INTERPOLATION_-SPOTWELD** (SPR3) to apply viscous damping.

10. For SPR2/SPR3, added an option to modify the nodal weights for force distribution. Adding a value of "10" to INTP triggers the new behavior. This new behavior consists of considering nodal areas and adding a facet participation factor to better consider distances between the SPR and associated nodes.

6.7 Contact

1. Added an initialization error termination check for MPP only. Before the decomposition, contact segments are mapped to the element they come from. Any not found will cause error termination. Also, improved the error message when an element is not found to output the nodes involved, so it is easier for the user to find the segment in question.

2. Added field IGTOL to MPP 2 on ***CONTACT_….** This field applies to ***CONTACT_AUTOMATIC_SINGLE_SURFACE** and ***CONTACT_-AUTOMATIC_GENERAL** in MPP. IGTOL is a scale factor used to help determine an "ignore" tolerance based on the segment and node thicknesses.

3. Changed the behavior of the bit flag GRP on ***CONTROL_MPP_CON-TACT_GROUPABLE** for segment-to-segment (SOFT = 2) contacts. Segment-to-segment contacts are excluded from the normal meanings of bit = 1 (on) and bit = 4 (off). Setting the 16 bit here does turn on groupable for segment-to-segment contacts, allowing for further testing.

4. When solid, cohesive elements are connected (as SURFA) using tied contacts, setting COHTIEM = 1 on ***CONTROL_CONTACT** causes the inclusion of the mass of the SURFB side to the time step estimation of the cohesive elements. This feature enables using low (or zero) cohesive density and decreases the mass scaling of the cohesive elements. Currently, it is not supported for groupable contacts.

5. Improved the accuracy of the segment-to-segment (SOFT = 2) contact intersection check to prevent false positives.

6. Implemented edge treatment options SRNDE = 1 and 2 (on Optional Card E) for ***CONTACT_AUTOMATIC_SURFACE_TO_SURFACE** in SMP for SOFT = 0 and 1.

7. Added STROBJ to ***CONTROL_CONTACT** to activate strongly objective

versions of non-groupable single surface contacts. Strong objectivity incurs an extra expense but may improve results in terms of better energy balance.

8. Added DIR_TIE on ***CONTROL_CONTACT** to enable a "directional tie" when a solid element is tied to its surroundings. With this option, solid nodes are preferentially tied in the direction of the outward normal to avoid a collapse of the solid elements to zero volume.

9. Added option SHLOFF to ***CONTACT_...** on optional Card G to consider shell offsets for individual contacts. SHLOFF is a contact-specific version of the global option CNTCO on ***CONTROL_SHELL**.

6.8 Control Cards

1. Setting SRTFLG = 1 on ***CONTROL_ACCURACY** causes the parts, contacts, nodal rigid bodies, and elements to be processed in an order sorted by the respective user IDs, regardless of the order that these appear in the input file. This feature helps ensure consistent results if, for some reason, the order of the above entities changes in the input file. SRTFLG can also be activated or deactivated through the command line options `SRTFLG=1` or `SRTFLG=0`. The command line option overrides the value specified in the keyword.

2. Added option OPTAPA to ***CONTROL_PORE_AIR** to specify how the simulation should proceed when the pore air portion of the simulation ends before the simulation ends.

3. In selective mass scaling (IMSCL ≠ 1 on ***CONTROL_TIMESTEP**):

    - Added support for using groupable tied contacts and contact type ***CONTACT_TIED_SHELL_EDGE_TO_SURFACE**.
    - The offset constraint in ***CONTACT_TIED ... CONSTRAINED_OFFSET** used to be formulated as a correctional force. Now, this is correctly enforced by a constraint.

4. Implemented a new algorithm for subcycling (***CONTROL_SUBCYCLE_...**) that should provide a more robust and faster execution.

5. Added option CRVP to ***CONTROL_SOLUTION** to possibly improve curve evaluation performance in special cases (see the manual description) and perhaps additionally reduce the memory requirement of rediscretized curves.

6. Reduced the memory requirement of detailed energies for materials

(MATEN = 2 on ***CONTROL_ENERGY**) by only requesting it after MPP decomposition.

6.9 Dual CESE Compressible Fluid Solver

1. Improved the robustness of the dual CESE solvers.

6.10 Elements

1. Added |SCOOR|=14 to ***SECTION_BEAM** which affects the update of the local coordinate system of discrete beams to improve rotational stability.
2. Switch to LAMSHT = 3 when LAMSHT = 1 on ***CONTROL_SHELL**. LAMSHT = 1 is only implemented for a few material models, and even for them, it does not seem to work properly.
3. Slight performance increase for DRCMTH = 1 on ***CONTROL_SHELL**.

6.11 Forming Analysis

1. Added optional check for the correct material type of the target to ***INCLUDE_STAMPED_PART** with field MTYPE. MTYPE provides the expected material type of the target part. If MTYPE does not match the material type of the target part, an error is thrown. It is useful when mapping history variables to avoid an unintended change of material type.

6.12 ICFD (Incompressible Fluid Solver)

1. Changes in ***DEFINE_CURVEs** values during a restart are now taken into account by the ICFD solver.

6.13 Implicit (Mechanical) Solver

1. Improved the hole-filling logic for the Lanczos Eigensolver (***CONTROL_IMPLICIT_EIGENVALUE**) for both the SMP and MPP versions. It was too aggressive for problems computing thousands of eigenmodes. This is a backport of an important patch from DEV and R15.
2. Improved the handling of interface linking (***INTERFACE_LINKING_FILE** for 2D problems by the implicit solver by ignoring the linking

between constraining and linked nodes on certain degrees of freedom if the two nodes have the same global single point constraints.

3. Improved the robustness of the error termination of the sparse direct linear equation solver. This improvement fixes a problem noted in metal-forming applications.

4. Provide cleaner termination and error handling for implicit cases where some of the processes do not have enough memory for a direct linear equation solution while other processes do have enough memory.

5. Changed the output for constraint modes to d3mode to be stiffness matrix times constraint modes for use in implicit modal dynamics (see ***CONTROL_IMPLICIT_CONSTRAINT_MODES**, ***CONTROL_IMPLICIT_MODAL_DYNAMICS**, and ***BOUNDARY_PRESCRIBED_MOTION**). This change impacts modal dynamics with prescribed motion.

6. Made MPP Lanczos (***CONTROL_IMPLICIT_EIGENVALUE**) more efficient in the rare event that the shift is too large.

6.14 Initial Cards

1. Allow the initialization of history variables based on nodes (***INITIAL_HISTORY_NODE(_SET)**) for the case that the same node is part of various definitions of node set. For instance, if a node is part of two node sets where the history variable #5 is initialized for the first node set and history variable #7 is initialized for the second, both history variables are now initialized for the node.

6.15 Load Cards

1. Support ***LOAD_THERMAL_BINOUT** in Mortar contact.

6.16 Materials and Equations-of-State

1. Account for additional costs of ***MAT_ADD_DAMAGE_DIEM/GISSMO** in MPP decomposition. The cost calculation already accounted for shells and the default cost estimate but now also accounts for solids and the newcost decomposition option in the pfile.

2. Added option LCSOFT to ***MAT_ADD_DAMAGE_GISSMO**. This field references a load curve or table ID. A curve gives the soft reduction factor

as a function of triaxiality. A table specifies the soft reduction factor as a function of triaxiality and element size. Like for SOFT, the sign of LCSOFT determines which strains are scaled by the factor.

3. Added new option to ***MAT_ADD_DAMAGE_GISSMO** for triaxiality-dependent regularization. Two new triaxiality values, RGTR1 and RGTR2, between 0 (shear) and 2/3 (biaxial) together with SHRF = 1 and BIAXF = 1 describe a trapezoidal tub-shaped regularization. This would already be possible with LCREGD<0, but the new approach is faster.

4. Setting |CMO| = 2 on ***MAT_RIGID** (***MAT_020**) enables applying the constraints or prescribed motion (***BOUNDARY_PRESCRIBED_MOTION**) of the rigid body about a specified coordinate.

5. Backported option VP = 4.0 for ***MAT_024** to invoke filtering/smoothing of the plastic strain rate. It is like VP = 1.0 but supports ***DEFINE_TABLE_COMPACT** like VP = 3.0.

6. Activated full integration of solid form 2 for ***MAT_058** (***MAT_LAMINATED_COMPOSITE_FABRIC**) to treat compressible behavior better.

7. Support IRATE from ***CONTROL_IMPLICIT_DYNAMICS** in ***MAT_058**, ***MAT_063** with MODEL > 0, ***MAT_187**, and ***MAT_280**.

8. Improved the viscoplastic algorithm in ***MAT_063** for MODEL ≥ 1. This change affects RFILTF = 0. Brent's method is used to avoid non-convergence.

9. Added a new option to ***MAT_063** with MODEL = 1 or 2. LCID can now refer to a ***DEFINE_TABLE_3D** to make the yield stress a function of strain (CURVE), strain rate (TABLE), and value of history variable #8 (TABLE_3D). History variable #8 can be set with ***INITIAL_STRESS_SOLID** or ***INITIAL_HISTORY_NODE**. This feature can be used to model foam with spatially varying porosity/density.

10. Added check and warning to ***MAT_187L** (***MAT_SAMP_LIGHT**). The shape of the uniaxial yield curves LCID-T and LCID-C can lead to problems for the plasticity algorithm due to initial softening.

11. Added history variables 6, 7, and 8 to ***MAT_COHESIVE_GENERAL** (***MAT_186**) to post-process the relative displacements.

12. Added new arguments to the functions in ***MAT_240_FUNCTIONS**: total and plastic separation components.

13. Added grouping option, GRPFT, to ***MAT_280** that causes scaling down the tensile strength with FTSCL at once for several parts.

14. For ***MAT_307** (***MAT_GENERALIZED_ADHESIVE_CURING**):
    - Added new curing models invoked with CKOPT = 4, 5, 6, 7, 8, 9, and 10 for multiple chemical species.
    - Added CKOPT = 11 to invoke a model-free kinetics approach for curing.
    - Added parameter TZERO to define the temperature value of 0 K in the current temperature unit set. It serves as an offset to make it possible to use the Celsius scale for curing simulations.
    - Added THOPT = 6 to invoke a combined extended WLF and exponential shift function for the horizontal temperature shift.
    - Added new input options for the Prony series. Instead of defining individual series for *G* and *K*, it is now possible to define a series for *E* or *G* and a constant Poisson's ratio.

6.17 MPP

1. Added MPP support for ***TERMINATION_CONTACT**.

2. Added ability to process the contacts in MPP with an ordering based on the contact IDs instead of the input ordering. In this way, if all contacts in the model have user IDs assigned, the contact processing should occur in an order independent of the actual input order of the contacts. This means you can rearrange your include files and not get any differences in the contact processing. Note that for R14.2, this behavior is optional and disabled by default, but for R15 and later major releases, this behavior is always enabled. To enable this feature in version R14.2, either include ***CONTROL_MPP_DECOMPOSITION_CONTACT_SORT** in the input deck or add the line `decomp { contact_sort}` to the pfile.

3. Added environment variable `LSTC_DIR_LOCAL` to specify the local direction for scratch files from an environment variable. For performance reasons, this directory should be on a local disk on each processor. Note that the pfile command `local` has priority over this environment variable.

6.18 Multiscale

1. Added new command line flag `nmsp` for running two-scale co-simulation jobs (see ***INCLUDE_MULTISCALE** and ***DEFINE_MULTISCALE**) in a very similar way to running a single LS-DYNA MPP job. The command becomes `mpirun -np 96 mppdyna i=input.key nmsp=32`, where nmsp specifies the number of MPI processors for the local model.

6.19 Output

1. For shells, write the parameter NLOC from ***SECTION_SHELL** to hisnames.xml.

2. Added field NSKIP to ***DATABASE_BINARY_RUNRSF/D3DUMP** for MPP and hybrid to reduce the frequency of producing full deck restart files. This option saves CPU time because processor 0 must collect all the information from the processors.

3. Added ***DATABASE_RCFORC_DR** to output rcforc_dr during dynamic relaxation.

6.20 Sensors

1. Added the option Io = ADDMASS for MTYPE = MATSUM to ***SENSOR_DEFINE_MISC**. This option allows the material's added mass to be traced by ***SENSOR**.

6.21 Thermal Solver

1. Increased the number of digits when writing ***LOAD_HEAT_GENERATION** IDs to the structured LSDA file. Now, it is possible to have more than 10^6 cards.

6.22 User-Defined Features

1. Added restart capabilities for dynamic/sharelib usermat using ***MODULE**.

2. Added PARAM1 = UCTRL and PARAM1 = UTIME for TYPE = UTIL in ***MODULE_USE**.

6.23 Miscellaneous

1. Added outputting a warning when an ***END** statement occurs in an encrypted file.

2. Added command line option `stdout=` to control the messages to stdout. See the manual for details.

3. Added printing information about the expiration date in the encrypted vendor block with DATE.

7 Bug Fixes

7.1 Acoustics, NVH, and Frequency Domain

1. Fixed print-out formatting in error handling associated with ***BOUNDARY_ACOUSTIC_COUPLING_MISMATCH** to accommodate large format numbers.

2. Fixed bug in the MATV computation (***FREQUENCY_DOMAIN_ACOUSTIC_BEM_MATV**) with variational indirect BEM (METHOD = 2) caused by the Skeletonized Interpolation implementation. The bug led to an incorrect solution.

3. Fixed bug in the BEM acoustics directivity plot (***FREQUENCY_DOMAIN_ACOUSTIC_DIRECTIVITY**) in MPP. Before the fix, the output frequencies were wrong.

4. For ***FREQUENCY_DOMAIN_RESPONSE_SPECTRUM**:

    - Fixed a bug in computing the absolute response in MPP, which led to wrong results.
    - Fixed a bug in DDAM in MPP. LS-DYNA crashed before this fix.

5. For ***FREQUENCY_DOMAIN_RANDOM_VIBRATION_FATIGUE**:

    - Fixed a bug in random vibration fatigue when the S-N curves are defined by ***MAT_ADD_FATIGUE**. This bug led to crashing when running random vibration fatigue on only one part of the model.
    - Fixed a bug in random vibration fatigue analysis in MPP when using element sets for fatigue analysis. This bug led to a crash.

7.2 Adaptivity

1. Fixed a bug in the nodal mass calculation when INMEMORY of ***CONTROL_ADAPTIVE** is on. This bug may lead to inconsistent results between in-core and out-of-core adaptivity, especially in deep-draw forming simulations.

2. Fixed bugs in in-core adaptivity that result in smaller-than-user-specified

element sizes when INMEMORY of ***CONTROL_ADAPTIVE** is on.

3. Corrected the warning message issued when IMSCL (selective mass scaling) in ***CONTROL_TIMESTEP** and INMEMORY of ***CONTROL_ADAPTIVE** are simultaneously on. In-core adaptivity does not support selective mass scaling.

4. Fixed error in the INTFOR output when INMEMORY of ***CONTROL_ADAPTIVE** is on.

7.3 ALE

1. For ***ALE_STRUCTURED_FSI**:

    - Fixed issue that led to incorrect results in 2D when coupling the S-ALE mesh to a beam Lagrangian structure. The FSI force applied was off by a factor of the radius.
    - Fixed bug causing restarts to crash in MPP due to not reinitializing the MPP communicator correctly.
    - Fixed issue causing wrong results in 3D when coupling the S-ALE mesh to a solid part Lagrangian structure undergoing oscillatory motion. A logic error caused wrongfully constraining the nodes in the S-ALE mesh, specifically, the nodes being swiped through by the Lagrangian solid parts.

2. For ***DATABASE_ALE_MAT** when used with S-ALE:

    - Fixed issue causing wrong pressure when running MPP with more than 1 core.
    - Fixed bug causing wrong momentum result output.

3. Fixed issue causing wrong results output due to incorrectly assigned history variables when using ***DEFINE_MATERIAL_HISTORIES_NAMES** with S-ALE.

4. When using ***DATABASE_FSI** with S-ALE:

    - Fixed wrong sign in the FSI pressure.
    - Fixed bug causing the wrong result by a factor of two of the accumulated mass that has been switched, which is output under the heading mout.

7.4 Boundary Cards

1. Fixed incorrect transformation of BIRTH/DEATH on ***BOUNDARY_SPC** when included with ***INCLUDE_TRANSFORM**. FCTTIM was not applied. Output to dyna.inc was also missing.

7.5 CESE Compressible Fluid Solver

1. Corrected checking for initial values being provided when ***CESE_INITIAL** is not provided.

2. Fixed FSI coupling involving a structural part that uses solid element type 13 (tetrahedral) elements. Using these elements previously led to a crash.

7.6 Constraint Cards

1. For ***CONSTRAINED_NODAL_RIGID_BODY_OVERRIDE**, fixed a bug that printed erroneous kinetic energy.

2. Bug fix for the combination of ***CONSTRAINED_NODE_SET** with ***DAMPING_PART_MASS** affecting MPP solutions only. The symptom was that the constraint was not obeyed for all of the nodes in the set, and warning MPP+156 was issued.

3. Fixed the internal energy computation for ***CONSTRAINED_SPR2** to avoid nonsensical results when damage reached 1.

4. Fixed issue when applying SPOTHIN to SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD**) in MPP. MPP synchronization was missing for the scaled contact thickness.

5. Fixed bug for SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD**) with MODEL > 10. Function IDs were not working with ***INCLUDE_TRANSFORM**, and large IDs ($> 2^{24}$) also failed. The same correction applies to ***MAT_265**.

7.7 Contact

1. Fixed an issue with frictional energy output for groupable surface-to-surface contacts. The issue could result in slightly incorrect energies being reported or in a segmentation fault under the following conditions:

    - ***CONTACT_AUTOMATIC_SURFACE_TO_SURFACE** interface with GRPABLE = 1

- FRCENG = 1 in ***CONTROL_CONTACT**
- PKP_SEN = 1 in ***DATABASE_EXTENT_BINARY**

2. Fixed inconsistency issues in the hybrid solver caused by ***CONTACT_TIED_SHELL_EDGE_TO_SURFACE_OFFSET** and ***CONTACT_AUTOMATIC_SINGLE_SURFACE**.

3. Fixed issue in determining the beam element contact thickness due to not honoring the thickness scaling factor in some cases. Specifically, ***CONTACT_AUTOMATIC_BEAMS_TO_SURFACE** was not honoring the SFSAT parameter.

4. Improved handling of nodes that are on the reference side of constraint-based tied contact interfaces while also being constrained with ***INTERFACE_LINKING_...**. For MPP non-groupable contact, this is already being handled well. But for groupable contact, all reference nodes were being removed from the LINKING interface, even if they did not have any tracked nodes tied to them. Now only those reference nodes actually having constraints due to tracked nodes being tied to them will be removed from the linking interface.

5. Fixed error in the reporting of untied nodes in some groupable tied contacts. If a node was close to tying in a groupable tied contact, but not close enough, the warning was not being properly issued. For nodes very far from tying, the warning was still correct. This bug affects all groupable tied contacts.

6. Fixed bug leading to nonconvergence when switching to implicit after an explicit phase including a (small) restart for input decks that include ***CONTACT_TIED_NODES_TO_SURFACE**, ***CONTACT_TIED_SHELL_EDGE_TO_SURFACE**, or ***CONTACT_TIED_SURFACE_TO_SURFACE**.

7. Fixed bug in penalty-based tied contacts that caused the optional contact stiffness to not be taken into account when the SURFB segments originated from solid facets.

8. Fixed possible issue with the consistency behavior (i.e., obtaining the same results when running the same problem with the same number of OpenMP threads on the same processor; see CONST on ***CONTROL_PARALLEL**) in the SMP and hybrid versions for segment-to-segment (SOFT = 2) contact.

9. Fixed the gap output in the interface force file when segment-to-segment (SOFT= 2) contact is used. It crashed if surfaces A and B share nodes. Fixing the gap output in the MPP version makes the gap values no longer depend on the number of processors used for the run.

10. Fixed a problem with the birth time option of MPP segment-to-segment (SOFT = 2) contact when the contact interface uses PSTIFF = 1. An error occurred when not all cores participated in the contact.

11. Fixed the segment-to-segment contact (SOFT = 2) thick segment pair check (SNLOG on Optional Card B of ***CONTACT_…**) for MPP ***CONTACT_ERODING_SINGLE_SURFACE**. The thick segment check identifies segment pairs on the contact surface that are too thick and too close together such that contact between them might generate spurious energy and unrealistic deformation. The error was causing this check to be ineffective. Also, a conflict between the thick segment pair check and ***CONTACT_EXCLUDE_INTERACTION** was resolved.

12. Fixed bug causing the hybrid version to hang when using eroding contact.

13. Fixed SMP problem with ***CONTACT_AUTOMATIC_…_TIEBREAK** for OPTION = 13 and 14. This issue could lead to errors (SOL+1345 or SOL+1346) if |ncpu| > 1.

14. Fixed an issue causing excessive forces when automatic tiebreak (***CONTACT_AUTOMATIC_…_TIEBREAK**) fails. This bug affects OPTION = 6, 7, 8, 9, 10, 11, 13, 14, and 101-105 (user-defined).

15. Fixed application of viscous damping (VDC) to automatic tiebreak with OPTION = 9, 11, 13, or 14. Before failure, these options use CN × area as the contact stiffness, not the regular penalty value. Now, they also use this for the additional damping stress.

7.8 Control Cards

1. Consistent mass treatment of rigid bodies (RBSMS = 1 on ***CONTROL_RIGID**) did not work with rigid-to-deformable switching.

2. In selective mass scaling (IMSCL ≠ 1 on ***CONTROL_TIMESTEP**):

    - The kinetic energy and momentum from moving rigid walls (***RIGIDWALL_…**) could be added twice.
    - The nodal inertia from spot welds was missing, leading to instabilities.

3. Labels Principal/Max Stress Range on ***DEFINE_MATERIAL_HISTORIES** did not work with dynamic relaxation.

4. For staged construction (***CONTROL_STAGED_CONSTRUCTION**):

    - Fixed incorrect calculation of the internal energy for dormant solid

elements. Dormant solid elements are solid elements (***ELEMENT_SOLID**) that belong to parts that are not yet active according to ***DEFINE_STAGED_CONSTRUCTION_PART**. Because the internal energy was wrong, the energy balance ("energy ratio") showed up as far different from unity. While this issue could appear alarming to users, it affected only the output values of energy and did not indicate any problem with the calculation itself (meaning stresses, displacements, etc.).

- When writing the dynain file from staged construction analysis, ELFORM = 3 beam elements with material ***MAT_NULL** were always skipped. This behavior is the correct action for autogenerated elements created for displaying spring and seatbelt elements from the d3plot file but not for user-created elements. A distinction is now made between these two categories.
- A bug affected models containing discrete beam elements (ELFORM = 6) if the parts containing these elements change from dormant to active during the simulation (STGA > 0 on ***DEFINE_STAGED_CONSTRUCTION_PART**). Symptoms occurred after the beams became active. The symptoms were unpredictable and could differ according to the model's contents and number of CPUs. They could range from being completely harmless to spurious forces in certain elements or a crash.

7.9 Dual CESE Compressible Fluid Solver

1. For the dual CESE immersed boundary method (IBM) FSI solvers, corrected some bugs that arise when the material erosion that occurs only involves thin (shell) structural parts. Other IBM FSI solver fixes include extensions for dealing with material erosion when some eroding parts are excluded from the FSI calculation.

2. Fixed some bugs in the 2D FSI-IBM Navier-Stokes solver. This fix may alter some of the results from previous versions.

3. Corrected the setup for the use of ***DEFINE_CURVE_FUNCTION** with the dual CESE solvers.

4. Corrected incorrect output to d3plot and binout.

7.10 Elements

1. Fixed issue where shells that were only connected to cohesive shells were deleted.

2. Shell elements with thickness stretch (ELFORM = 25, 26, and 27 on ***SECTION_SHELL**) did not work in adaptive simulations. The thickness stretch was not properly transferred to the new mesh.

3. Fixed ***ELEMENT_MASS_PART** with thick shell elements. It was calling an incompatible routine that caused an error termination.

4. Fixed an error in the MCID option of ***ELEMENT_SHELL**, which was calculating the wrong material direction.

5. Fixed thick shell composite modeling when different material models are specified in different element layers while using Rayleigh damping. Material history data was being overwritten.

6. Corrected a bug that caused spurious damping to be applied when ***ELEMENT_DIRECT_MATRIX_INPUT** and rigid parts (or ***CONSTRAINED_NODAL_RIGID_BODYs**) are present in the same model. The bug affected implicit dynamic transient analysis (IMASS = 1 on ***CONTROL_IMPLICIT_DYNAMICS**).

7. Fixed bug for ***ELEMENT_DISCRETE** with ***DEFINE_SD_ORIENTATION** and a deflection limit provided with ***SECTION_DISCRETE**. This combination could cause a crash.

8. Corrected indexing error when using two or more superelements (***ELEMENT_DIRECT_MATRIX_INPUT**) with ***BOUNDARY_SPC** applied to the nodes of at least one superelement that was not the first one. This issue only impacts explicit time integration. The error would have shown up during matrix assembly of the superelement system with the error message including the term LCPACK.

9. Fixed bug in mapping internally generated part IDs to parts IDs given in the input file for composite shell elements (***ELEMENT_SHELL_COMPOSITE**) for writing the dynain file.

10. Corrected the computation of the number of through-thickness integration points for NUMFIP < 0 on ***DEFINE_ELEMENT_EROSION**. Prior to this fix, the calculation of the number of through-thickness integration points was incorrect, leading to an incorrect percentage computation and potentially incorrect erosion behavior.

11. Fixed issue with mass scaling of cohesive solids (***SECTION_SOLID** with ELFORM = 19 to 22). Inverted elements (negative volume) could lead to a huge negative added mass. Replacing current volume by initial volume fixes this issue.

12. Fixed shell thickness update with PSTUPD on ***CONTROL_SHELL**. This

feature has not working properly for ELFORM = 16 since May 2021 (previous R14 releases).

13. Fixed bug for ***PART_STACKED_ELEMENTS** with INPLCMP = 1. If new shells should be generated, errors could occur.

7.11 EM (Electromagnetic Solver)

1. Fixed an MPP bug that could prevent an Eddy current 2D axisymmetric simulation from starting if the model was small and the number of CPUs used was large.

2. Fixed a bug that could cause wrong results when using wedge elements in ***EM_CIRCUITS_SOURCE** parts.

3. Fixed a crash that could happen when ***EM_EXTERNAL_FIELD** was used with ***EM_CONTROL_CONTACT**.

4. Fixed a minor issue when ***EM_CONTACT_RESISTANCE** was combined with ***EM_RANDLES_BATMAC** that led to incorrect results and could cause the job to fail.

5. Fixed issue with broadcasting parameters defined for ***EM_RANDLES_-EXOTHERMAL_REACTION** to all CPUs in MPP when using ***EM_-RANDLES_SOLID** or ***EM_RANDLES_TSHELL**.

6. Fixed an output issue to d3plot in the current collector conductivity when using ***EM_RANDLES_BATMAC**.

7. Fixed an issue in the Joule heating term sent to the tabs in ***EM_RAN-DLES_BATMAC** that could cause small inaccuracies.

7.12 Implicit (Mechanical) Solver

1. Fixed bug when using LSOLVR = 22 - 26 on ***CONTROL_IMPLICIT_-SOLVER** in MPP that caused the simulation to hang. The bug typically manifested in situations with a small number of degrees of freedom combined with a large number of MPI ranks.

2. Fixed bug causing the d3eigv files not to close properly when using the LOBPCG eigenvalue extraction method (EIGMTH = 102 on ***CONTROL_-IMPLICIT_EIGENVALUE**. The failure to close properly led to an error termination when using the files with other keywords, such as ***FRE-QUENCY_DOMAIN_SSD**.

3. Fixed bug in Sectoral Symmetry (EIGMTH = 111 on ***CONTROL_IMPLICIT_EIGENVALUE**) that yielded (easily identifiable) incorrect results.

4. Fixed a memory allocation error that may cause a segmentation fault when using ***CONTROL_IMPLICIT_GENERAL**.

5. Fixed bug for implicit dynamics analysis (IMASS = 1 on ***CONTROL_IMPLICIT_DYNAMICS**). If a model contains many load curves, each with a large number of points, the analysis could take longer to run than necessary. The time taken per time step would increase with time, meaning the model would run slower and slower as the analysis proceeds.

6. Corrected the reading of the d3mode file in modal dynamics (***CONTROL_IMPLICIT_MODAL_DYNAMIC**) to properly handle whether stresses are present in that file or not independent of stresses present in the d3eigv file. This issue impacts any modal dynamics simulation using prescribed motion when the presence of stresses differs between d3eigv and d3mode.

7. Corrected reading of d3eigv and d3mode for modal dynamics (***CONTROL_IMPLICIT_MODAL_DYNAMIC**) when some hexahedral elements have 10 nodes and some do not. Previously, it was assumed that the hexahedral element either all had 8 nodes or all had 10 nodes.

8. Fixed using superelements in explicit for SMP, which was broken in R14 due to an upgrade of the sparse linear equation solver. This was not a problem in MPP.

9. Corrected an indexing error in the MPP implementation when using superelements (***ELEMENT_DIRECT_MATRIX_INPUT**) with implicit mechanics. Also, corrected an MPP issue with forces on the dependent nodes of rigid bodies connected to superelements.

10. Corrected MPP-only issue due to improper indexing when creating the superelement mass damping matrix with ***CONTROL_IMPLICIT_MODES** and ***DAMPING_GLOBAL** or ***DAMPING_PART_MASS**.

11. Corrected the handling of nodal mass matrices (***ELEMENT_MASS_MATRIX**) for the implicit eigenvalue problem (***CONTROL_IMPLICIT_EIGENVALUE**). The nodal mass was being added twice to the assembled mass matrix, causing the computed eigenvalues to be too small.

12. Fixed incorrect frequency of the residual vector output to d3resvec (***CONTROL_IMPLICIT_RESIDUAL_VECTORS**).

13. Corrected an array allocation error for the case of implicit mechanics with

inertia relief to deal with the increased order of the linear algebra problem.

14. Corrected output to **d3eigv** for SMP for large problems to make it the same as MPP. The record size was incorrect, corrupting the states. Thus, post-processors could not properly process the data.

15. Made two corrections to the output for ***CONTROL_IMPLICIT_-MODES**:

    - Reset the number of eigenvalues in the case of fewer computed than requested due to an interval specification so that the output matches the number computed.
    - Ensure the output or not of stress is consistent to keep the d3mode file correct.

7.13 Initial Cards

1. Fixed incorrect element offsets for ***INITIAL_STRAIN_SHELL** and ***INITIAL_STRAIN_TSHELL** when they are in an included file with nonzero element offsets.

2. Fixed issue where ***INITIAL_STRESS/STRAIN_SHELL** in long format was not written correctly to dynain.

3. Fixed issue where unit scaling with ***INCLUDE_TRANSFORM** did not work correctly for ***INITIAL_STRESS_SECTION**.

4. Fixed the internal energy computation when using ***INITIAL_FOAM_-REFERENCE_GEOMETRY**. If used in a run with dynamic relaxation, the energy could become negative.

5. Fixed some ***INITIAL_STRAIN_SHELL** output in the dynain file (written with ***INTERFACE_SPRINGBACK_LSDYNA**). The parametric coordinate T of the through-thickness integration points could have been wrong, mainly when using ***PART_COMPOSITE**.

7.14 Materials and Equations-of-State

1. Fixed issue with ***MAT_ADD_DAMAGE_DIEM** by not extrapolating the strain rate tables (2D) given by P1.

2. Fix for ***MAT_ADD_DAMAGE_GISSMO**. Damage is driven by plastic strain (DTYP = 0 or 1) or a history variable (DTYP ≥ 10). If that history variable is not monotonically increasing (plastic strain always is), damage

could grow even below the already-reached maximum value. This behavior is now prevented by remembering the maximum value. See also IFLG4 = 1 on ***MAT_ADD_GENERALIZED_DAMAGE**.

3. Fixed incorrect table evaluation of LCSDG on ***MAT_ADD_DAMAGE_GISSMO** when it is a ***DEFINE_TABLE_4D**. The table evaluation was not working correctly for the strain rates, and the temperature was just zero in a purely mechanical analysis.

4. Fixed issue for ***MAT_ADD_DAMAGE_GISSMO** for the unlikely event of using shells with Lode parameter dependent FADEXP < 0 (***DEFINE_TABLE_3D**) or LCREGD < 0 (***DEFINE_TABLE_3D**). Shell elements do not need Lode dependence anyway.

5. Bug fix for *MAT_ADD_DAMAGE_GISSMO and solid elements: There was a mistake in the Lode parameter computation when LCREGD < 0 referred to a ***DEFINE_TABLE_3D** or FADEXP < 0 referred to ***DEFINE_TABLE_3D**.

6. Fixed combination of tetrahedron type 13 and material models with an equation of state (***EOS_...**). A wrong new volume value was used in the energy update, leading to unstable results. This issue affected ***MAT_015** (EOS mandatory), ***MAT_224** (when using an EOS), and ***MAT_260** (when using an EOS).

7. Fixed incorrect shell element deletion behavior for ***MAT_024** with VP = 1, 2, or 4. The element was deleted only when the last integration point failed. The corrected behavior is that the element should only be deleted when all integration points fail.

8. Fixed incorrect scaling of the yield stress for shell elements with model ***MAT_024_STOCHASTIC** when VP = 1 and LCSS is defined with a table.

9. Fixed issue for ***MAT_024** with MITER = 2 on ***CONTROL_SHELL**. The yield stress on history variable #5 could be zero if SIGY was not defined, leading to NaNs in the constitutive matrix for implicit.

10. Report the plastic strain of an integration point reaching FAIL for ***MAT_024** only once. Previously, failure of the same integration point was reported many times.

11. ***MAT_034** (***MAT_FABRIC**) did not work with ***DEFINE_STAGED_CONSTRUCTION_PART** or ***LOAD_STIFFEN_PART**.

12. Fixed bug for the combination of ***MAT_USER_DEFINED_MATERIAL_MODELS** with IORTHO=1 and shell type 23/24. The number of

integration points was incorrect for orthotropic user materials with these shells, leading to an error.

13. Corrected problem with the number of history variables in user-defined materials (***MAT_USER_DEFINED_MATERIAL_MODELS**) with solid elements when options INTOUT/NODOUT of ***DATABASE_EXTENT_BINARY** are set to "STRAIN" or "ALL." It was already fixed in 2014 for explicit (`subroutine urmathn`), but now it is also fixed for implicit (`subroutine urtanh`).

14. Modified longitudinal tensile failure (XT) of ***MAT_ENHANCED_COMPOSITE_DAMAGE** (***MAT_054**) in implicit solutions when DFAILT = 0. This option was developed to fail slowly over many cycles, which works okay for explicit solutions but prevents the failure of implicit solutions. Failure is now immediate in implicit solutions.

15. For ***MAT_058** (***MAT_LAMINATED_COMPOSITE_FABRIC** with shell elements when EA, EB, or GAB < 0:

    - Use the initial, undamaged stiffness to compute the sound speed/time step from the curves/tables. Prior to this fix, constant, hard-coded values were used, leading to an incorrect time step when shells with this material determine it.
    - Fixed bug in the table evaluation of EA, EB, or GAB < 0 for shell elements. Prior to this fix, the table may not have been evaluated correctly by not using the correct load curve associated with a specific strain rate.

16. Made ***MAT_058_SOLID** work with AOPT = 4.

17. Fixed bug for ***MAT_079** (***MAT_HYSTERETIC_SOIL**). The strain rate effect (input field LCSR giving enhancement factor versus strain rate) worked only for a limited range of curve shapes. It worked okay for curves with a constant gradient but not for some other shapes. Symptoms of the bug could include either LCSR being completely ineffective or a noisy response with stresses sometimes dropping back to the non-rate-enhanced level. Furthermore, if the first strain-rate point in the curve LCSR was input as zero, error SOL+1082 was tripped unnecessarily. Zero is now allowed.

18. Fixed behavior of ***MAT_081** with solid elements when using nonzero LCDM and EPPFR. If the plastic strain exceeds EPPFR, the element is deleted irrespective of LCDM. This changed behavior matches the behavior of this material for shell elements.

19. Fixed bug for ***MAT_098** with solid elements initialized by ***INITIAL_STRESS_SOLID** through a dynain file. The initial volume was not

properly scattered to all the integration points.

20. Fixed an error in solid element weld assemblies with OPT set to 0 or -1 on ***MAT_100**, which erroneously used the torsional strength term for the in-plane shear strength and the in-plane shear strength for the torsional strength. This error caused welds to fail at the wrong stress unless they were dominated by Mode I failure.

21. For ***MAT_SPOTWELD** (***MAT_100**), fixed mixing up the resultant failure moments (MRR, MSS, and MTT) for beam and hexahedral spot welds. The error had an impact if different values for MRR, MSS, and MTT were defined.

22. Fixed issue for solid spot welds used in implicit with IACC = 1 on ***CONTROL_ACCURACY**. The initialization of solid element weld failure tables was missing. Therefore, options like ***MAT_100** with OPT = 10, ***MAT_100_DA** with ***DEFINE_CONNECTION_PROPERTIES**, and ***MAT_240_FUNCTIONS** did not work correctly.

23. Fix for the internal energy computation in ***MAT_123** with VP = 1 and ELFORM 13 tetrahedral solids. The energy could have been wrong (e.g., negative) if all the elements in a vector block were elastic.

24. Fixed issue for ***MAT_124** when a huge number of curves (> 9999) is used in a model. This bug could lead to an error or the material using the wrong curve.

25. Fixed issue with ***MAT_124** (***MAT_PLASTICITY_COMPRESSION_TENSION**) for solid elements when SRFLAG = 2. We increased the maximum number of iterations from 20 to 100 for the (slow) Ridders' method. Potential nonconvergence led to error termination.

26. Fix for ***MAT_133** when used with plain strain or axisymmetric elements (ELFORM = 13, 14, or 15 on ***SECTION_SHELL**). This combination did not work before. The stresses were likely zero all the time.

27. Fixed bug for ***MAT_135** (***MAT_WTM_STM**) that caused SIGMA0 < 0 (yield curve) to not work for WTM (FLG = 2).

28. Fixed issue with ***MAT_159** when used with thick shells type 3, 5, and 7. Initialization of history variables was missing.

29. Fixed a bug in ***MAT_179** affecting the stress extraction from tables.

30. Fixed bug in ***MAT_COHESIVE_GENERAL** (***MAT_186**) that resulted in negative damage (meaning healing) when the mode-mixity changed under load reversals. This issue was most apparent for brittle and weak

materials.

31. Fixed issue for ***MAT_187L** when RATEOP = 1 and LCID-C is specified as a table. A potential change of the Drucker-Prager slope during return mapping was not correctly considered, leading to wrong stresses.

32. Made several corrections/improvements for shells with ***MAT_SAMP_-LIGHT** (***MAT_187L**), such as always using Brent's method if LCID-T and LCID-C are different tables with an improved start value for the method.

33. For ***MAT_209** (***MAT_HYSTERETIC_BEAM**):

    - Fixed bug causing the shear utilization (extra history variables 49 and 50) to be output as zero for some elements. The bug affected output only.
    - Fixed bug that occurred when a very large number (such as 1.0E25) was entered in a field that can be either a scale factor (positive real number) or a load curve (negative integer), such as SFSHS. Symptoms could include a crash during the input stage or a nonphysical response or failure during the solution phase.

34. Limit SLIMXT to 0.99 on ***MAT_213** (***MAT_4A_MICROMEC**). This restriction resolves the fiber stress dropping to 0.

35. Fixed the thickness computation in ***MAT_240** with THICK = 0.0 for pentahedral cohesive elements (ELFORM = 21 and 22).

36. Fixed a bug in the latent heat calculation for the 3D version of ***MAT_254**. Special handling for axisymmetric solids was missing, which could result in segmentation violations.

37. Determine the current E/PR at the current temperature for ***MAT_255**. They were determined at the center temperature, but that did not match with the computation of the average value and the increment.

38. For ***MAT_261** (***MAT_LAMINATED_FRACTURE_DAIMLER_PIN-HO**), always use the absolute value of strain rate in the table evaluation. Prior to this change, negative values of strain rates would have led to a wrong table evaluation.

39. For ***MAT_262** (***MAT_LAMINATED_FRACTURED_DAIMLER_-CAMANHO** with shell elements when EA, EB, or GAB < 0:

    - Use the initial, undamaged stiffness to compute the sound speed/time step from the curves/tables. Prior to this fix, incorrect values were used, leading to an incorrect time step when shells with this material determine it.

- Fixed bug in the table evaluation of EA, EB, or GAB < 0 for shell elements. Prior to this fix, the table may not have been evaluated correctly by not using the correct load curve associated with a specific strain rate.

40. Fixed type 6 and 7 hourglass control with ***MAT_264** (***MAT_TABULATED_JOHNSON_COOK_ORTHO_PLASTICITY**) and ***MAT_224_GYS** (***MAT_TABULATED_JOHNSON_COOK_GYS**). The material constants were wrong, causing unpredictable hourglass behavior.

41. Fixed bug for ***MAT_264** when using CMPFLG = 1 in ***DATABASE_EXTENT_BINARY**. The stresses were not transformed to the local material frame.

42. Avoid negative strain rates for ***MAT_280** with RATENL > 0 or FT < 0.

43. Fixed issue for ***MAT_280** with thick shell elements. Sudden crack propagation through the thickness with option NIPF = 1 did not work as intended.

44. Fixed stress-update routine for ***MAT_307** that led to an unphysical response for the viscoelastic stresses.

45. Fixed bug in using large curve IDs (> 16.7 million) in ***MAT_S15** (***MAT_SPRING_MUSCLE**). This bug led to an error reporting the load curve as undefined.

7.15 MPP

1. Fixed issue with MPP local coordinate system calculations when using ***DEFINE_COORDINATE_NODES** with DIR input as Y or Z. These cases were not working correctly and could produce incorrect output.

2. Exclude PLOTEL elements during MPP decomposition because not excluding them caused inconsistent results due to changing the PLOTEL definition.

3. Fixed I/O operations that might cause simulations with REMSPH set to 1 or 2 in ***CONTROL_MPP_DECOMPOSITION_REDECOMPOSITION** to crash immediately after a redecomposition.

7.16 Output

1. Fixed rare case where a parameter expression (***PARAMETER_EX-**

PRESSION) might not get echoed to the d3hsp file. This lack of echoing only happened when the ***PARAMETER_EXPRESSION** instantiation was the last keyword in an include file.

2. Fixed a bug in finding the cross-sectional force (***DATABASE_CROSS_SECTION** that occurred when the section has 2D seat belts (***ELEMENT_SEATBELT**). The contribution from the 2D belts to the sectional force was ignored.

3. Fixed issue where ***DATABASE_RCFORC** could cause a segmentation fault for AVX2 binaries.

4. Fixed issue where ***DATABASE_CROSS_SECTION_PLANE** with a local coordinate system gave erroneous moments.

5. The option to update reference nodes for beams (NREFUP = 1 on ***CONTROL_OUTPUT**) did not work in adaptive simulations.

6. Fixed bug associated with ***DATABASE_RBDOUT**. Displacements were not being output.

7. Fixed error in output files when QUADSLD and CUBSLD of ***DATABASE_EXTENT_BINARY** are greater than 0. This bug affects MPP only. It corrupted the output files, leading LS-PrePost to crash.

8. Fixed the mass calculations for parts that are output to ***DATABASE_SSSTAT**. Previously, the wrong geometry was used, causing the overall mass to decrease.

9. Fixed issue with ***DEFINE_MATERIAL_HISTORIES** when Label set to Plastic Strain Rate and tetrahedral elements. The output to the history variable could have been incorrect.

10. For ***DATABASE_BINARY_D3MAX**:

    - Updated the equations for computing principal stress and strain to be consistent with those used in LS-PrePost.
    - Fixed bug in writing d3max when rigid body solid elements are present. Before the fix, the rigid body solid elements incorrectly showed nonzero stress.
    - Fixed bug in writing strain results for solid elements in d3max. Before the fix, the strain results in d3max were incorrect.

7.17 Restarts

1. Fixed an issue where ALE data being output to the d3full file could, in some

cases, corrupt the d3full file, resulting in unpredictable behavior when restarting from the d3full file.

2. Fixed restart issue in MPP for models including type 13 solid (tetrahedrons) elements. The issue led the restart to fail.

3. Fixed bug for restarts with pore pressure analysis (***CONTROL_PORE_FLUID**). The bug only manifested under the following simultaneously met specific conditions:

   - restarting from d3dump or d3full files using Full Deck Restart (see ***STRESS_INITIALIZATION**);
   - parts referred to a nonzero ACURVE on ***BOUNDARY_PORE_FLUID**; and
   - the analysis type at time = 0 is drained, but the analysis type at the restart time is not drained.

   Under these conditions, the pore pressures from the previous run would not be carried across to the new run.

7.18 Sensors

1. Fixed a bug for ***SENSOR_DEFINE_FORCE** when TYPE = JOINT. The sensed results could depend on the joint definition sequence.

2. Fixed outputting erroneous error message for ***SENSOR_DEFINE_FORCE** when FTYPE is PRESC-MOT. The bug led to outputting error message KEY+157 (`BOUNDARY_PRESCRIBED_MOTION_SET ### not found`).

7.19 SPH

1. Fixed issue with computing pressures on the mesh surface associated with ISPH through ***DEFINE_SPH_MESH_SURFACE**. The bug caused the program to crash.

7.20 Thermal Solver

1. Fixed bug when using LSOLVR = 12 - 16 on ***CONTROL_THERMAL_SOLVER** in MPP that caused the simulation to hang. The bug typically manifested in situations with a small number of degrees of freedom combined with a large number of MPI ranks.

2. Fixed bug in SOLVER = 17 on ***CONTROL_THERMAL_SOLVER** for

single precision executables, leading to (easily identifiable) incorrect results.

3. Fixed issue where mechanical history variables could not be read by thermal materials for tetrahedrons and pentahedrons.

4. Fixed bug in thermal parts that are part of TIED_WELD contacts in MPP. The tied condition being fulfilled or not was not being communicated when the contact segments are on different processors.

7.21 User-Defined Features

1. Fixed issue where ***MODULE_USE** could not be used for thermal materials.

2. Fixed issue where shear strain was not treated correctly in the external usermat inferface (EXT > 0 on ***MAT_USER_DEFINED_MATERIAL_MODELS**).

3. Fixed combination of ***PART_AVERAGED** and ***MODULE**. A missing part ID could lead to a crash or error (SOL+1378: `No user subroutine (usrmat) is loaded for part 0`).

4. Fixed issue with ***USER_INTERFACE_FRICTION**. Determining element history variables could go wrong if triangular shell elements were involved. Also, a large number of history variables were not taken care of correctly.

5. Fixed format issue with ***USER_INTERFACE_FRICTION** when using `long=s`.

7.22 Miscellaneous

1. For ***COSIM_FMI_INTERFACE**, fixed a bug causing incorrect solutions that occurred when an imported curve prescribed displacement (VAD=2 in ***BOUNDART_PRESCRIBE_MOTION**).

2. Fixed a bug in using ***INCLUDE_TRANSFORM** with ***NODE_TRANSFORM** that occurred when the node set is defined by BOX or VOL. The node set could be transformed in an unexpected way.

3. Fixed a bug when using ***SET_SHELL_LIST_GENERATE** that happened when BiBEG and/or BiEND is not defined. The shell list was not generated correctly.

4. Fixed issue where ***DEFINE_CURVE_FUNCTION** could overwrite previously defined curve functions if no coordinate system was specified.

5. Made fixes for keyword format signs +, -, and %. Mixing those different format signs did not work in every case. See the section "GENERAL CARD FORMAT" in the manual for a description.

6. Avoid error termination when ***DEFINE_CONNECTION_PROPERTIES** is used with (D)SIGY < 0.

7. Fixed issue with ***DEFINE_MULTI_SHEET_CONNECTORS**. Different parts/materials for joining elements JNTxx did not work.

8. Fixed issue with ***DEFINE_SD_ORIENTATION**. In large models (> 16.8 million nodes), it was possible that the internal node IDs of NID1 and NID2 were the same, leading to error STR+509 (`orientation vector 8: nodes are coincident`).

9. Fixed misleading error message for ***DEFINE_TRANSFORMATION** output if POS6N was used with nodes not yet defined. The error message had the wrong node ID.

10. Fixed potential memory issue with ***DEFORMABLE_TO_RIGID** using part sets. This could have led to a segmentation violation.

11. Consider IDDOFF from ***INCLUDE_TRANSFORM** for REGION on optional Card E of ***CONTACT_...**.

12. Fixed issue with ***PART_AVERAGED**. A segmentation fault during initialization was possible if nodes were not numbered in a certain way. The numbering should not matter, and now, it doesn't.