

Release Notes for R13.1

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§1 Release notes revision

This file constitutes revision 0 of the release notes for LS-DYNA version R13.1.0.

§2 License

The string "REVISION 13" must appear in the LS-DYNA license file in order to run version R13. Please contact your LS-DYNA distributor or your Ansys sales representative if you need to have your license updated.

§3 Documentation

Documentation for R13.1.0 is provided in the R13.0 User's Manuals which may be downloaded from www.lstc.com/download/manuals. For features mentioned in these release notes but which appear to be missing from the R13.0 User's Manuals, please refer to the DRAFT User's Manuals at www.lstc.com/download/manuals. Please note that not all features in the DRAFT User's Manuals are available in version R13.1.0.

§4 Notes

The remainder of this file provides a brief description of new features, enhancements, and bug fixes in version R13.1.0. Some of the bug fixes may have also been included in R12.1.0.

The items are arranged by category. Understand that in many cases, a particular item may pertain to more than one category. In the interest of brevity, each item is listed only one, under a single category.

§5 New

§5.1 Constraint Cards

1. First experimental version to support solid element parts connected by ***CONSTRAINED_INTERPOLATION_SPOTWELD** (SPR3).

§5.2 Contact

1. Added new feature called ***CONTACT_EXCLUDE_INTERACTION** which allows a set of segments to be excluded from contact with another set of segments or a set of segments to be excluded from all contact. The types of sets supported are segment sets, shell element sets, and part sets.

§5.3 ICFD (Incompressible Fluid Solver)

1. Added full support for ICFD species transport capabilities. FSI and adaptive remeshing are fully functional. The following keywords were added for this feature:
 - ***ICFD_MODEL_SPECIES_TRANSPORT**
 - ***ICFD_BOUNDARY_PRESCRIBED_SPTRANSP_CONC**
 - ***ICFD_INITIAL_SPTRANSP**
 - ***ICFD_DEFINE_SPTRANSPSOURCE.**

§5.4 Materials and Equations-of-State

1. A new model for composites ***MAT_213** / ***MAT_COMPOSITE_TABULATED_PLASTICITY_DAMAGE** is available. It is an orthotropic, combined visco-elastic-plastic and damage material model. You input tabulated stress-strain and damage curves with the option of providing quasi-static curves only or stress-strain and damage curves that are temperature and strain rate dependent. Element erosion criteria can be specified with the Puck Failure Criterion, Tsai-Wu Failure Criterion, or a Generalized Tabulated Failure Criteria. Both solid and thin shell elements are supported. Probabilistic modeling of some material parameters is available. References are in Volume II of the User's Manual.

§5.5 Miscellaneous

1. Enable support for the ***VENDOR_LICENSE** scheme both with the FlexLM server and with the `lstc_server` licensing system.

§6 Improvements and Enhancements

§6.1 Airbag Cards

1. For ***AIRBAG_PARTICLE**:

- Support ***SENSOR_SWITCH_SHELL_TO_VENT** with $IAIR = 1$.
- Added outputting gauge pressure is to the CPM interface force file (***DATABASE_BINARY_CPMFOR**).
- New keyword option **TIME** to shift the CPM active time for more consistent results while changing fire time with ***SENSOR_CPM_AIRBAG**.
- Enhanced **BLOCK** field for better consistency with the following changes:
 - Evaluate contact force based on airbag nodes. Each airbag collects data independently.
 - The contact force from a force transducer is excluded to avoid a false signal.
- Added flag **IBLOCK** to ***DEFINE_CPM_VENT** to allow you to change blockage treatment for each vent individually.

§6.2 Blast

1. Added reporting the particle molar ratio between the predefined HE and air particles for ***DEFINE_PARTICLE_BLAST**.
2. Redistribute HE and air particles every 200 cycles for particle blast method to get consistent results while varying core counts.

§6.3 Constraint Cards

1. For ***CONSTRAINED_NODAL_RIGID_BODY_OVERRIDE**, added optional synchronization card to automatically turn off related contact, airbag, and prescribed motion when the overriding nodal rigid body is on and turn them back on when the related overriding rigid body is off.
2. **PID1** and **PID2** on ***CONSTRAINED_INTERPOLATION_SPOTWELD** can now refer to part sets, not just single parts. A value of less than zero indicates that it is a set, meaning $PID1 < 0$

references a part set with ID |PID1|. This feature could be used for in-plane composed sheets, such as Taylor welded blanks.

3. Added new possible dependence on the “peel ratio” for certain fields on ***CONSTRAINED_INTERPOLATION_SPOTWELD** (SPR3) and ***MAT_265_SPR3** for MODEL = 1. The peel ratio is the ratio of the bending moment to the resultant axial force. This value is kept constant when plastic yield is reached. Three fields can depend on the peel ratio:
 - RN < 0: Curve with ID |RN| specifies tensile strength as a function of peel ratio
 - LCUPF: Table for plastic initiation displacement as a function of mode mixity and peel ratio
 - LCUPR: Table for plastic rupture displacement as a function of mode mixity and peel ratio
4. Added two output quantities for SPR3 to binout / swforc: “mode_mixity” and “peel_ratio”.

§6.4 Contact

1. Improved the behavior of segment-based contact (SOFT = 2) in implicit solutions. Problems should converge better.
2. 2D mortar contact is supported for MPP.
3. Support ***CONTACT_TIED_SURFACE_TO_SURFACE** for multi-stage analysis using FTYPE = 3 on ***INTERFACE_SPRINGBACK_LSDYNA**.
4. Extended option DTPCHK used in ***CONTACT_...** with SOFT = 2. A negative value (meaning DTPCHK < 0) invokes an initial error check. If any intersection pairs are found, the simulation stops.

§6.5 Control Cards

1. Added IACC = 2 on ***CONTROL_ACCURACY** for compatibility between explicit and implicit when performing multistage analysis through FTYPE = 3 on ***INTERFACE_SPRINGBACK_LSDYNA**. In particular, it invokes strongly objective tied contact algorithms, even for explicit analysis, in addition to selected “implicit” features.

2. Added new option `ENDMAS < 0` on ***CONTROL_TERMINATION**. A curve with `ID = |ENDMAS|` provides `ENDMAS` as a function of total mass.

§6.6 Discrete Element Method

1. Enhanced injection of bonded DES (***DEFINE_DE_INJECT_BONDED**) for better consistency with changing core counts.
2. Enhancement for particle to structure contact algorithm to reduce runtime.

§6.7 Elements

1. If the shell reference surface is offset by `NLOC` (***SECTION_SHELL**) or `OFFSET` (***ELEMENT_SHELL**), the time step size of those shell elements is reduced to fix instabilities. The reduction of the time step size is based on numerical tests which show a dependence on the offset distance and the ratio of shell thickness to edge length (T/L). Instabilities were most likely observed for aspect ratios of $T/L > 0.5$.
2. We added field `NLOCDT` to ***CONTROL_SHELL** to decide if the time step size is reduced when the shell reference surface is offset. `NLOCDT = 0` is the default and reduces the time step size to fix instabilities. `NLOCDT = 1` restores the prior behaviour and does not reduce the time step size at the risk of instabilities.
3. Enabled the `ORIENTATION` option of ***ELEMENT_BEAM** to work with beam form 9 (spot welds).
4. Reduced drilling stiffness in cohesive element 20 (***SECTION_SOLID**) to suppress the influence of non-physical resistance.
5. Improved accuracy of solid element -18, related to the solution of internal compatibility equations.
6. If the shell reference surface is offset by `NLOC` (***SECTION_SHELL**) or `OFFSET` (***ELEMENT_SHELL**), the time step size of those shell elements is reduced to fix instabilities. The reduction of the time step size is based on numerical tests which show a dependence on the offset distance and the ratio of shell thickness to edge length (T/L). Instabilities were most likely observed for aspect ratios of $T/L > 0.5$.

7. Added new keyword option MISC for ***SECTION_SOLID**. The first new parameter is cohesive thickness, COHTHK. This allows section / partwise definition of cohesive thickness. This value supersedes the one from ***MAT_240** or ***MAT_ADD_COHESIVE**.
8. Support GISSMO failure for 2D XFEM (ELFORM = 52 with FAILCR = 0 on ***SECTION_SHELL_XFEM**).
9. For ***FREQUENCY_DOMAIN_SSD**:
 - Implemented ERP only computation with d3ssd output skipped to speed up the computation. Previously ERP required d3ssd output.
 - Extended RESTDP (an option to restart from binary scratch file dumpssd) to nodout_ssd. Previously it worked only for d3ssd.

§6.8 EM (Electromagnetic Solver)

1. Added support for the 2D axisymmetric feature to the monolithic solver.

§6.9 ICFD (Incompressible Fluid Solver)

1. Reorganized the windkessel boundary condition for Fluid-Structure Interaction cases which should improve robustness.

§6.10 Implicit (Mechanical) Solver

1. Enhanced the output message when no eigenvalues were computed using ***CONTROL_IMPLICIT_BUCKLE** or ***CONTROL_IMPLICIT_EIGENVALUE**.
2. Added new option for line search in the implicit solver, LSTOL < 0 on ***CONTROL_IMPLICIT_SOLUTION**. This option ensures that prescribed motions are automatically satisfied, regardless of step size. This should avoid the infamous message "Convergence prevented due to unfulfilled bc..."

§6.11 Isogeometric Analysis (IGA)

1. For ***IGA_SHELL**, check the trimming curves and limit the generated sampling points to the parametric space of the underlying surface

description. This reduces bad parameterizations given by “dirty” geometry definitions.

2. For ***IGA_SHELL**, check if proper in-plane integration rule is set. An appropriate error message is output.
3. Allow IGA elements (***IGA_SHELL** and ***IGA_SOLID**) to be treated as rigid bodies.
4. Enhancement for IGA element (***IGA_SHELL** and ***IGA_SOLID**) erosion: Add element-type information to the message file specifying IGA elements and related interpolation elements.
5. Add a check to see if ***IGA_POINT_UVW** is within a valid knot-span. If the location of an ***IGA_POINT_UVW** (connected to a ***NODE**) is not within a valid knot-span of the underlying face, a warning message will be written and this point/node pair will be removed.

§6.12 Load Cards

1. Added keyword option **SET_ONCE** to ***LOAD_NODE** to evaluate the load function only once. The value is stored and applied for the rest of the run.
2. Support ***LOAD_SEISMIC_SSI_DECONV** for unstructured meshes or for meshes with small element height.

§6.13 Materials and Equations-of-State

1. Extended capability of $LCREGD < 0$ on ***MAT_ADD_DAMAGE_GISSMO**. $|LCREGD|$ can now refer to a ***DEFINE_TABLE_3D**. This makes the regularization factor a function of Lode parameter, triaxiality, and element size.
2. Extended functionality of $FADEXP < 0$ in ***MAT_ADD_DAMAGE_GISSMO**. $|FADEXP|$ can refer to ***DEFINE_TABLE** (fading exponent is a function of element size and triaxiality) or ***DEFINE_TABLE_3D** (fading exponent is a function of element size, triaxiality, and Lode parameter).
3. Added new flag INSTF for instability treatment to ***MAT_ADD_DAMAGE_GISSMO**. This flag governs the behavior of instability measure, F , and fading exponent, $FADEXP$:

- INSTF = 0: F is incrementally updated, and FADEXP, if from a table, is allowed to vary.
 - INSTF = 1: F is incrementally updated, and FADEXP is kept constant after $F = 1$.
 - INSTF = 2: F is only 0 or 1 (after ECRIT is reached), and FADEXP, if from a table, is allowed to vary.
 - INSTF = 3: F is only 0 or 1 (after ECRIT is reached), and FADEXP is kept constant after $F = 1$.
4. Extend option LCSDG < 0 in ***MAT_ADD_DAMAGE_GISSMO** by adding new function arguments: strain rate, temperature, history variable, and element size. So now we have $epf = epf(\text{triaxiality}, \text{Lode parameter}, \text{plastic strain rate}, \text{temperature}, \text{history}, \text{element size})$.
 5. Make damage / failure a function of strain rate, temperature, Lode parameter, and triaxiality for ***MAT_ADD_DAMAGE_GISSMO**. Therefore, parameters LCSDG > 0 and ECRIT < 0 can now refer to ***DEFINE_TABLE_4D** to make failure / critical strain a function of plastic strain rate (TABLE_4D), temperature (TABLE_3D), Lode parameter (TABLE), and triaxiality (CURVE).
 6. Extensions for ***MAT_ADD_GENERALIZED_DAMAGE** with IFLG2 = 1. It now supports the following additional material models for solid elements: ***MAT_133**, ***MAT_199**, and ***MAT_233**.
 7. Improved plasticity / creep algorithm for ***MAT_ADD_INELASTICITY**. The improved algorithm is more efficient and robust.
 8. Added more materials as potential weld partner materials for PROPRUL = 2 / 3 of ***DEFINE_CONNECTION_PROPERTIES**: types 3, 81, 133, 187, 224, and 243.
 9. Make explicit and implicit analysis of ***MAT_HYPERELASTIC/OGDEN_RUBBER (*MAT_077)** compatible when used with multistage analysis using FTYPE = 3 on ***INTERFACE_SPRINGBACK_LS-DYNA**.
 10. Improved ***MAT_FU_CHANG_FOAM (*MAT_083)** for implicit/explicit multistage analysis. Explicit and implicit were using different algorithms for damage causing an incorrect transition between stages. This is remedied now by setting IACC = 2 on ***CONTROL_ACCURACY**.

11. Added new keyword option `PATH_DEPENDENT` for ***MAT_083**. This is a new path dependent, incremental formulation for foams. It supports ***DEFINE_TABLE_3D** for TBID with additional dependence on the volumetric strain $(1 - J)$.
12. For ***MAT_091/092** modified initialization of material directions for solid elements when FANG is used. There was an invisible option BETA for many years in field 8 of card 3. Before this update solids used the invisible BETA, but shells used FANG to input a material rotation angle. With this update, FANG will be used by solids too if it is nonzero. However, if `FANG = 0.0`, then the hidden BETA will be used for backward compatibility.
13. Improved plasticity algorithm of ***MAT_SIMPLIFIED_JOHNSON_COOK_ORTHOTROPIC_DAMAGE** / ***MAT_099** to avoid numerical issues such as division by zero and floating point overflows.
14. Added flag `VERM` to ***MAT_187** (SAMP-1) and ***MAT_187L** (LIGHT) with `LCEMOD > 0`. `VERM` can activate / deactivate (0 / 1) the equilibrium yield condition.
15. Improved robustness in the creep algorithm of ***MAT_THERMO_ELASTO_VISCOPLASTIC_CREEP** (***MAT_188**).
16. Added field `DOSPOT` to ***MAT_GENERAL_SPRING_DISCRETE_BEAM** / ***MAT_196** which activates spot weld thinning when discrete beams that use the material are tied to shell elements. This behavior was turned on by default, but now this parameter must be used to activate it.
17. Added logarithmic interpolation support for `BETA < 0` on ***MAT_224**. If keyword option `LOG_INTERPOLATION` is used, and `|BETA|` refers to a ***DEFINE_TABLE_4D**, then logarithmic interpolation is used in the strain rate direction.
18. Add optional rate filtering method `RFILTP` to ***MAT_240**: exponential moving average of the effective plastic strain rate (`RFILTP > 0`) or of the effective total strain rate (`RFILTP < 0`).
19. Added two new options to ***MAT_240** to govern yield under compression (`COMPY`) and enable smooth treatment of asymptotic limits (`SMOLIM`). These fields are currently only available if none of the keyword options `THERMAL`, `3MODES`, or `FUNCTIONS` is used.

20. Improved ***MAT_UHS_STEEL (*MAT_244)** for implicit. The transition between transformation and plasticity caused a discontinuity in the response.
21. Added strain rate filtering parameter, SRFILT, to ***MAT_252** to apply an exponential moving average.
22. Performance improvements for ***MAT_258**: If input parameters A and GAMMA (exponents) are integers, then use them like this internally as well (real exponents are quite expensive).
23. Improved creep algorithm in ***MAT_BERGSTROM_BOYCE_RUBBER (*MAT_269)** that should reduce numerical roundoff sensitivity.
24. New case for ***MAT_280** to allow $FT < 0$ to be used with $FTSCL > 0$. In that case, $|FT|$ defines a curve for tensile strength vs. strain rate, and FTSCL scales the strength values from that curve as long as material is intact. If cracked, neighbors get non-scaled values from that curve.

§6.14 MPP

1. Added support for SECFORC file with dynamic load balancing (***CONTROL_MPP_REBALANCE**).

§6.15 Multiscale

1. The two-scale cosimulation feature (***INCLUDE_COSIM**) now uses a simplified MPI command as follows:

```
1 mpirun -np 36 mppdyna i=input.k ncsp=24 jobid=jid
```

The “ncsp” flag informs LS-DYNA that the local model runs on a separate job using 24 out of total 36 MPI processes in this case. The name of the main input file for the local model must have the same name as the main input file for the global model, except with the prefix “cs_” appended to it. For example, if the global model’s main input file is called `input.k`, then the local model’s file must be called `cs_input.k`. The main input files for both the global and local models must be in the same working folder.

2. Offsets for the tied contact between the global and local models in two-scale cosimulation (***INCLUDE_COSIM**) is supported.

§6.16 Output

1. Support NPLTC for ***DATABASE_BINARY_D3DUMP**, ***DATABASE_BINARY_RUNRSF**, ***DATABASE_BINARY_DEMFOR**, and ***DATABASE_BINARY_INTFOR**.
2. Support LCDT and IOOPT for ***DATABASE_BINARY_D3DUMP**.
3. Enabled orientation data to be written to the dynain file for beam elements with ORIENTATION data. This data is written if the beam has rotated.
4. Support plastic strain tensor output for tetrahedron element type 10; see STRFLG on ***DATABASE_EXTENT_BINARY**.
5. Support ***INITIAL_STRAIN_TSHELL** with ***INTERFACE_SPRINGBACK_EXCLUDE**.
6. Take care of special characters in part titles for hisnames.xml (see HISNOUT on ***CONTROL_OUTPUT**). We now replace &, " , < , > , and ' with & , " , < , > , and ' to avoid problems with XML file readers.
7. Added field DELERES to ***DATABASE_EXTENT_BINARY** to write last available results to d3plot and d3part for deleted elements.
8. Added two new quantities for SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD**) to binout / swforc database: "resultant_axial" (manual: F_n) and "resultant_shear" (F_s).
9. Print header text of ***DEFINE_CURVE_TITLE** to d3hsp.
10. Print header text of ***DEFINE_COORDINATE_..._TITLE** to d3hsp.
11. Added echo of command line options to screen, d3hsp, and messag.

§6.17 Sensors

1. Added the option of local force/moment output for FTYPE = JOINTSTIF (joints with added stiffness) on ***SENSOR_DEFINE_FORCE**.

§6.18 Miscellaneous

1. Created a new set of PGP encryption keys for LS-DYNA, marking the old ones as “Obsolete” (but of course we still support reading files encrypted with the old keys). Two keys are implemented, a 1024 bit key and a 2048 bit key. Use the command line option `pgpkey` to get the new encryption keys.
2. Create a new keyword option for ***PARAMETER** and ***PARAMETER_EXPRESSION**. If “**_NOECHO**” is appended, the defined parameters will not be echoed to the `d3hsp` file.
3. Suppress echo of encrypted lines that follow an unrecognized keyword.
4. Add new `CUST_DATE` type for the ***VENDOR_BEGIN** / ***VENDOR_END** licensing. The string `CUST_DATE` is in the first field, the `MM/DD/YYYY` expiration date is in columns 11-20, and a string customer ID is in columns 21-80. With the existing LST license types (`lstc_server` and `nodelocked`), the customer ID will be checked against a program `OPTION` named “`CUSTOMER_NUM`”. If they do not match (or `CUSTOMER_NUM` is not set), the `VENDOR` block will be skipped. We plan to eventually add this for the FlexLM licenses.
5. Added new field `IMMED` to ***NODE_TRANSFORM**. This field allows you to control the processing sequence of ***NODE_TRANSFORM**.
6. Minor speed improvement for keyword parser if many instances of ***DEFINE_TABLE_COMPACT**.
7. Accuracy enhancement for `DXRB` / `DYRB` / `DZRB` of ***DEFINE_CURVE_FUNCTION**. They now work with `EXACC = 1` on ***CONTROL_ACCURACY**.

§7 Bug Fixes

§7.1 Acoustics, NVH, and Frequency Domain

1. For ***FREQUENCY_DOMAIN_FRF**, fixed a bug in reading the `d3eigv` database when modal stress is present. The bug caused an error termination.

2. Fixed a bug in the input phase when running BEM acoustics ***FREQUENCY_DOMAIN_ACOUSTIC_BEM** in MPP with pre-decomposition. The bug resulted in an error termination.

§7.2 Adaptivity

1. Fixed 2 memory clobbers associated with ***CONTROL_ADAPTIVE**:
 - The process of determining neighboring elements across adaptive constraints was not correct, causing more data to be stored than there was room for. The improper data is now properly discarded. This only affects problems running with in-core adaptivity.
 - MPP groupable contact was not correctly estimating the size of some required storage, in rare cases this could result in an array overrun.
2. Fixed bug related to applying boundary conditions to new nodes created using in-core adaptivity (INMEMORY = 1 on ***CONTROL_ADAPTIVE**). The bug caused the boundary condition to be applied incorrectly.

§7.3 Airbag Cards

1. Fixed bug for ***AIRBAG_WANG_NEFSKE** when used with ***AIRBAG_INTERFACTION**. The bug might result in a segmentation fault.
2. Fixed bug in ***SENSOR_CPM_AIRBAG** birth time shift to make it work for all shell element formulations that work with ***MAT_034**. It was only working for element formulation 12. It should now work for shell element formulations 12, 13, 14, 22, 23, and 24.

§7.4 ALE

1. For ***ALE_STRUCTURED_FSI**:
 - Fixed leakage control bug in 2D that led to incorrect results.
 - Fixed leakage control bug when fractional mass is used (PFAC > 0.0). The bug led to instability.
 - Fixed memory bugs that led to crashes for the Windows versions.
 - Fixed memory bugs that led to crashes for the MPP versions.

2. Fixed bug in S-ALE with moving HE (***ALE_STRUCTURED_MESH_MESH_MOTION**). The bug caused the detonation time to be kept the same after advection.
3. Fixed bug in MPP version for S-ALE moving mesh. Mesh coordinates were not being communicated properly between processors.
4. Fixed memory bug for S-ALE mesh motion that could cause LS-DYNA to crash.
5. Fixed issue in the expansion ratio calculation in each direction for S-ALE mesh motion. The issue occurred when the mesh did not expand or contract causing a divide by zero issue in the calculation.
6. Fixed MPP bug for S-ALE mesh motion that led to some data being stored in the wrong location.

§7.5 Boundary Cards

1. Fixed bug in the MPP version associated with using ***DEFORMABLE_TO_RIGID_AUTOMATIC** with ***BOUNDARY_PRESCRIBED_MOTION**. This bug intermittently caused segmentation faults. The SMP version does not have this issue.
2. Fixed bug in determining if the input data cards for ***BOUNDARY_PZEPOT** are in the new or old format (NSID, LCID, SF, ID). The check was initially just based on the existence of ‘ ’ in the SF field of the old format, but this check missed certain cases, particularly when the input deck came from LS-PrePost.
3. Fixed issue when a define function is used for prescribing accelerations on rigid bodies (***BOUNDARY_PRESCRIBED_MOTION_RIGID_LOCAL**). It was not implemented but included in the documentation.

§7.6 Constraint Cards

1. Fixed issues with the explicit implementation of ***CONSTRAINED_INTERPOLATION** in single precision that were leading to an error termination.
2. Fixed a bug for ***CONSTRAINED_GENERALIZED_WELD_BUTT** which was created when ***CONSTRAINED_NODAL_RIGID_BODY_OVERRIDE**.

3. For ***CONSTRAINED_NODAL_RIGID_BODY_OVERRIDE**, fixed an MPP bug that happens when trying to resume a contact that was initially turned off.
4. Fixed issues with the explicit implementation of ***CONSTRAINED_INTERPOLATION** in single precision that were leading to an error termination.
5. Bug affecting results from ***CONSTRAINED_SOIL_PILE** for elements on the boundaries between MPP domains.
6. Fixed serious bug for the case where an input deck includes both ***CONSTRAINED_NODAL_RIGID_BODY** and ***CONSTRAINED_NODAL_RIGID_BODY_INERTIA**. Incorrect logic caused the inertia properties to be put on the wrong nodal rigid bodies.
7. Fixed influence of helix angle in ***CONSTRAINED_JOINT_GEAR**s in implicit. It was not being accounted for.
8. Fixed incorrect motion for ***CONSTRAINED_JOINT_RACK_AND_PINION** in implicit.
9. Fix for ***CONSTRAINED_INTERPOLATION**: failure flag in `swforc` was not showing failure correctly.
10. Changed location of failed visualization beams for SPR3 (***CONSTRAINED_INTERPOLATION_SPOTWELD**). Failed beam elements in a deformed model were flying away. Now they stay with the disconnected sheets.
11. Fix for ***CONSTRAINED_INTERPOLATION_SPOTWELD** with `MODEL > 10`, where selected material parameters are defined as functions (***DEFINE_FUNCTION**). This did not work correctly for function IDs > 9999.

§7.7 Contact

1. Set missing flag that caused the **_ONLY** keyword option to be ignored in ***CONTACT_TIEBREAK_SURFACE_TO_SURFACE_ONLY** in MPP.
2. Improve MPP handling of ***CONTACT_AUTOMATIC_TIEBREAK** with `OPTION = 4` when the tied nodes slide off the edge of the constraining surface.

3. Fix MPP energy balance calculation for ***CONTACT_TIED_SHELL_EDGE_TO_SOLID** which was not computing the master side energy correctly.
4. Suppress initial penetration check for the MPP groupable implementation of ***CONTACT_..._INTERFERENCE** which was basically bypassing the interference part completely.
5. Force MPP eroding contact initialization checks for eroded elements when using redecomposition if necessary. This fixes issues that could result in deadlock.
6. Fix for ***CONTACT_RIGID_SURFACE** initialization which has in some cases been using the wrong coordinates in the single precision version of the LS-DYNA starting with R10.0.
7. Fix for MPP groupable drawbead behavior when the contact is off the edge of a thin triangle. The (u, v) coordinates were not being truncated along the $u + v = 1$ line, and the computed mass was coming out negative due to extrapolation. This resulted in NaNs during the friction calculation.
8. Improved contact segment “remove duplicate” handling so that it is less sensitive to input changes and better honors the I2D3D field on optional Card B of ***CONTACT_OPTION**.
9. Fixed MPP ***CONTACT** when the following conditions are met:
 - either optional Card A is not defined or SOFT = 0 or 1 on Card A
 - the ORTHO_FRICTION keyword option is used
 - at least one of LC1S, LC2S, LC1M or LC2M is defined

For this set of conditions, the friction behavior is likely to be changed by this fix. The friction forces were developed in one direction of sliding, but not when reversed 180 degrees. The behavior is now symmetric.

10. Fixed segment-based contact when used with PSTIFF > 0 and selective mass scaling. Segment masses were being scaled incorrectly causing excessive stiffness.
11. Fixed the contact energy density when segment-based contact is used (*SOFT = 2 on *CONTACT). The values were too low.

12. Fixed the peak pressure calculation for contact (***DATABASE_EXTENT_BINARY**). Tributary areas for the nodal forces were not being accounted for, so the calculated peak was too high.
13. Fixed the ***CONTACT** option to use SSID = 0 with single surface contact to include all parts when ***ELEMENT_SHELL_COMPOSITE** is used in the model.
14. When the slave side is rigid for ***CONTACT_AUTOMATIC_NODES_TO_SURFACE**, the slave side contact thickness offset was considered 0 unless SHLTHK was set to 2 on ***CONTROL_CONTACT**. Since it is an automatic contact, the contact thickness offset should always be considered. The contact thickness offset is now considered regardless of the setting of SHLTHK.
15. Fixed bug in the SMP version of ***CONTACT_SURFACE_TO_SURFACE**. This contact is two-way, but one-way contact was being performed.
16. Fixed bug in initial penetration check for automatic beam to surface contact (***CONTACT_AUTOMATIC_BEAMS_TO_SURFACE**) for triangular segments. The initial penetrations were not computed correctly which led to incorrect penetration reports and wrong contact forces. For larger models mainly comprised of quadrilateral segments, the error was hardly noticeable.
17. Fixed bug in mortar contact between higher order segments. An incorrect area calculation caused wrong contact forces.
18. Fixed output of penetrations in mortar contact when PENOUT on ***CONTROL_OUTPUT** is used. Too many (incorrect) penetrations were reported in explicit analysis.
19. Fix for implicit tiebreak contact: history variables were not properly stored causing a hang, seg fault or incorrect results (SMP only).
20. Fixed history variable treatment and element report for user mortar tiebreak.
21. Fixed typo causing incorrect forces in tied contact when used with FTORQ on Optional Card E of ***CONTACT_OPTION** (MPP only).
22. Fixed serious bug in mortar contact for explicit analysis. Contact damping was broken and had no effect.

23. Fixed bug in mortar eroding contact. Some arrays were not properly reallocated as new contact segments were generated.
24. Fixed mortar tied contact for full deck restart. It was resulting in a segmentation fault.
25. Fixed bug where tied (shell edge) contacts with null shells in the slave definitions sometimes erroneously invoked spcs on the resulting structure. This error happened in implicit analysis if the null shells were covering solid elements (only), and at the same time the tied contacts coupled to the rotational degrees of freedom of the null shells.
26. Fixed beam mass calculation for ***CONTACT_AUTOMATIC_BEAMS_TO_SURFACE**. Beams with ***MAT_NULL** and $RO < 1.e-11$ get zero nodal mass, but that could lead to later problems in contact. It is now resolved.
27. Fix for cohesive element failure issue with MPP groupable tied contact. Groupable tied contact does not initialize until the first cycle, so checking the "is this node tied" flags before then was causing premature element failure.

§7.8 Control Cards

1. Fixed strongly objective algorithm for solid elements, activated by $IACC = 1$ on ***CONTROL_ACCURACY**, making sure stresses are exactly zero at time zero of a simulation.
2. Fix typo that caused spurious energy growth in rigid walls when used with selective mass scaling (***CONTROL_TIMESTEP**).
3. Added missing restart / adaptivity handling for $MATEN = 2$ of ***CONTROL_ENERGY**: detailed material energies were not transferred from one step to the next.
4. Fix for $MATEN = 2$ on ***CONTROL_ENERGY**: for solid elements, energy results could have been wrong.
5. Fix for combination of $DT2MSLC$ on ***CONTROL_TIMESTEP** and ***MAT_187** leading to problems with curve generation.
6. Added missing curve offset and transformations for $DT2MSLC$ on ***CONTROL_TIMESTEP**.

§7.9 Discrete Element Method

1. Bug fix for DEM nonreflecting boundary condition in MPP. The input data was being lost when it was transferred to the local processors. In some cases, this issue led to the feature being disabled.
2. Fixed bug for beam types 2 and 3 with ***DEFINE_DE_TO_BEAM_COUPLING** to get the correct beam thickness.

§7.10 Dual CESE Compressible Fluid Solver

1. Fixes were made for many bugs related to material erosion in the dual CESE immersed boundary method (IBM) FSI solver. For efficiency, an optimization was implemented for an expensive portion of setting up the FSI interface.
2. Issues were corrected with the dual CESE moving mesh method FSI solver, and a test was enabled that permits the full mesh morphing calculation to be avoided when the FSI displacements are small enough.
3. Finally, some bugs were corrected related to axisymmetric boundary conditions. It is likely that the dual CESE axisymmetric boundary conditions did not work prior to this release.

§7.11 Elements

1. Fixed mass scaling of solid tetrahedral element form 13. When mass scaling, an incorrect element volume was used, causing a wrong amount of added mass. Elements with a volume of around 1.0 would get about the right amount of added mass. Those with larger volume would get too little, and those with smaller volume too much.
2. Fixed some initialization checks related to ***PART_AVERAGED**, and prevented execution of related code on processors that have none of these beams (MPP only).
3. The d3plot file was becoming corrupted when a 4-node element formulation was specified for 8-node shell elements. An error message is now issued when an improper element formulation is specified for 8-node shell elements.

4. Fixed bug in connectivity of extra degrees-of-freedom for shell elements 25 and 26 (***SECTION_SHELL**). The issue could cause a seg fault.
5. Enabled ***DEFINE_ELEMENT_EROSION_TSHELL** to work with thick shell forms 3, 5, and 7 that use material type 54 with DFAILT and DFAILC.
6. Fixed shell element composite modeling when ESORT on ***CONTROL_SHELL** is set to sort triangular elements into triangle forms, and the sorting changes the number of in-plane integration points or the ordering of the data. This feature was not working.
7. Fixed mass scaling for solid element form 62.
8. Fixed seg fault when 2D SPH are used in MPP.
9. Fix for ***PART_STACKED_ELEMENTS**: memory overwrite. Models could fail with "Error 10183 (KEY+183), part ... not defined," even if that part did not exist at all.
10. Improved element quality check for solid cohesive elements by making the error criterion independent from units and increasing the accuracy of internally used variables.

§7.12 EM (Electromagnetic Solver)

1. Fixed issue which was causing some Eddy current simulations to run slower than they had for R12.
2. Fixed issue in EM nodout output for MPP. Multiple CPUs could contribute to the total value.

§7.13 Fatigue Cards

1. Fixed a bug in writing d3ftg for fatigue analysis based on modal dynamics (***FATIGUE_MODAL_DYNAMIC**). The control data for the number of variables for each element was not correct.
2. Multiaxial fatigue analysis (***FATIGUE_MULTIAXIAL**) with solid elements was not being performed when requested.

§7.14 ICFD (Incompressible Fluid Solver)

1. Fixed issue in SMP for the immersed interface solver. A memory error resulted in a segmentation fault at run time.
2. Fix in contact angle calculation for surface tension problems which should improve behavior.
3. Fixed infinite pointout print for steady state solver cases.
4. Fixes in simple restart capabilities for ICFD.
5. Fix in Ergun Correlation inertial term factor after reading model parameters from the input deck (PMCTYPE = 1 in ***ICFD_MODEL_POROUS**). It was using the permeability instead of the porosity.
6. Rollback the definition of the Forchheimer term (PMCTYPE = 2 in ***ICFD_MODEL_POROUS**). A factor of 1/2 was introduced while testing around mid-2020.

§7.15 Implicit (Mechanical) Solver

1. Correct output of eigenvectors to d3eigv when performing a buckling analysis using the power method (***CONTROL_IMPLICIT_EIGENVALUE**).
2. Correct output of rotational entries of eigenvectors to the d3eigv file. Output speed improvements we made in R12 introduced the problem.
3. Correct ***CONTROL_IMPLICIT_MODAL_DYNAMICS** to correctly use ***LOAD_BODY_OPTION**.
4. Kinetic energy was nonzero for implicit statics problems.
5. Augmentation stiffness was incorrectly calculated for the Lagrangian multiplier approach of ***CONSTRAINED_RIGID_BODY_STOPPER**.
6. Fixed output of dissipated internal energy in implicit analysis, reported as "eroded internal energy" in the glstat file. The values were incorrect.
7. Removed influence of the eigenvalue control card when explicit analysis is performed.

8. Fixed initial time step in implicit full deck restart. The implicit time step was not being transferred through the restart files, so it restarted with the DT0 parameter on ***CONTROL_IMPLICIT_GENERAL**. It was also not accounting for the time step limitations on ***CONTROL_IMPLICIT_AUTO**.

§7.16 Initial Cards

1. Bug fix for ***INITIAL_AXIAL_FORCE_BEAM** used with KBEND = 1 in implicit. If the beam did not align with the X, Y, or Z-directions in the global coordinate system, the results were not consistent.
2. Fixed bug in ***INITIAL_AXIAL_FORCE_BEAM** when KBEND = 1. The transformation between the local and global system was not being accounted for correctly.
3. Fixed structured input error that occurred when defining ***INITIAL_VELOCITY_GENERATION** with ID = 0 and STYP = 0 with another ***INITIAL_VELOCITY_GENERATION** with nonzero ID and STYP.
4. Fixed bug in which ***INITIAL_VELOCITY_GENERATION** yields the wrong velocity for ***CONSTRAINED_NODAL_RIGID_BODY_INERTIA** when CID is nonzero.
5. Fixed initial velocity (generation) when used with constrained nodal rigid bodies and inertia elements. The inertia of the elements were not properly accounted for when calculating the velocity.

§7.17 Isogeometric Analysis (IGA)

1. The determinate of the integration points for ***IGA_SOLID** was not passed to the subroutine which calculates the internal energy reported in glstat.
2. Incorrect cross section force output (***DATABASE_CROSS_SECTION**) occurred when the cross section had more than one IGA patch. It worked correctly for one patch.
3. Fixed a bug for multiple connections with ***IGA_TIED_EDGE_TO_EDGE**, where more than two faces are tied along the same edge. The bug showed up only in MPP. Prior to this fix, the tying behavior might be wrong, depending on the number of cores used.

4. Fixed some memory issues with IGA elements (***IGA_SHELL** and ***IGA_SOLID**) that may have led to error termination for very large models.
5. Fixed bug in MPP for contact that occurred for models that contain IGA elements (***IGA_SHELL** and ***IGA_SOLID**). Prior to this fix, models with surface-to-surface or node-to-surface contacts may have terminated unexpectedly.
6. Fixed a bug in SMP for multiple threads for ***IGA_SHELL/SOLID** and ***ELEMENT_SHELL/SOLID_NURBS_PATCH**. This bug only showed up for a multi-patch analysis with different polynomial degrees in the patches.

For ***IGA_SHELL**:

- Fix for the removal of failed IGA elements and their related interpolation elements. In rare cases and on rather large hybrid models (IGA elements and standard FE elements in the same model), unexpected behavior may have started after the failure of IGA elements.
- Correctly flag associated interpolation elements to fail, when the parent IGA elements fail (get deleted). This might have been wrong when triangular elements were in the model.
- Fix for synchronization of shared interpolation nodes in MPP.
- Fix for using ***RIGIDWALL** in MPP together with IGA elements. Prior to the fix, if some processors did not contain IGA elements, deadlock could occur.

§7.18 Load Cards

1. ***LOAD_VOLUME_LOSS** did not work correctly when COORD is nonzero, and the coordinate system had certain characteristics. The symptom was warning message SOL+1127 in the message file.
2. In the single precision version, erroneous warnings and errors occurred for load curves used for ***LOAD_SEISMIC_SSI_DECONV**. The errors indicated that the load curves had unequal time steps (equal time steps are required) when they did not.
3. Resolve parallel inconsistency when using ***LOAD_SEISMIC_SSI** in SMP or hybrid. It was giving different results for different values of $ncpu < 0$.

§7.19 Materials and Equations-of-State

1. Fix for ***MAT_ADD_DAMAGE_GISSMO** with LCSDG being a ***DEFINE_TABLE_3D**. The first value in the sub-table was interpreted as logarithmic strain rate, and logarithmic interpolation was used in that case. But it is the Lode parameter and interpolation should be linear.
2. Fix for combination of ***MAT_ADD_DAMAGE_GISSMO** and ***PART_COMPOSITE**. If the first layer in the composite is a non-GISSMO material, failure treatment could have been wrong.
3. Fix for large curve IDs for $SIGVM < 0$ and $MXEPS < 0$ (absolute values greater than 2^{24}) on ***MAT_ADD_EROSION**. LS-DYNA issued a missing curve error.
4. Fixed output of effective plastic strain for ***MAT_ADD_INELASTICITY**. If used in conjunction with a plastic material in the first place, it was incorrectly overwritten.
5. Fixed missing load curve ID transformation (***INCLUDE_TRANSFORM**) for $PERM_i / LCPGD_i$ on ***MAT_ADD_PORE_AIR**.
6. Fixed a bug for ***MAT_ADD_PZELECTRIC** that occurred when the eigenvalue calculation was requested. The bug caused a seg fault.
7. Fixed single precision issue in ***MAT_005** to reduce noisy stresses.
8. Fixed the transformation of the material tangent in ***MAT_022** and ***MAT_054** which is used in implicit analysis. Previously, if elements deviated from a perfect square shape the stiffness and results like eigenvalues changed.
9. Fixed issue in ***MAT_PIECEWISE_LINEAR_PLASTICITY/*MAT_024** with $VP = 1$ when used with tetrahedra elements (ie tet13) after dynamic relaxation. The problem showed up when the part reached plastic deformation during dynamic relaxation.
10. Fixed error in the strain rate calculations of ***MAT_PIECEWISE_LINEAR_PLASTICITY (*MAT_024)**. For certain tables the incorrect value of yield stress was extracted.
11. Fix for combination of ***MAT_024** (shells) with $TDEL > 0$ and GISSMO. History variables conflict could lead to wrong results.

12. ***MAT_024** with VP = 3 for H-L beam elements now supports LCSS being a ***DEFINE_TABLE_{X}D** with dimension X > 2. Prior to this fix, 3D tables and larger only worked for shells and solids.
13. Fixed issue in ***MAT_030** where plasticity routine failed to converge for shell elements.
14. Fixed falsely triggered error message for ***MAT_033** with N = 0.
15. For ***MAT_037/*MAT_TRANSVERSELY_ANISOTROPIC_ELASTIC_PLASTIC**, when used for shells with thickness stretch, there was a bug in the numerator for plastic strain update, leading to incorrect results.
16. For ***MAT_LAMINATED_COMPOSITE_FABRIC (*MAT_058)**, if EA and EB were specified as ***DEFINE_CURVES**, the scale and offset factors (SFA,OFFA) were not taken into account in an error check.
17. Fixed bug for ***MAT_077** that occurred for shell elements only. The bug caused a seg fault.
18. Fixed bug in plane stress algorithm of ***MAT_HYPERELASTIC / OGDEN_RUBBER (*MAT_077)**.
19. **MAT_079 (*MAT_HYSTERETIC_SOIL)** exhibited spurious stress changes for elements that rotate significantly. Errors are small for typical seismic or civil/structural applications but could potentially become problematic, such as in highly deforming regions of the soil.
20. AOPT < 0 on ***MAT_122_3D** was not working for this material. Also added missing d3hsp echo of material parameters for this material.
21. Fix for combination of ***MAT_126** and ***MAT_ADD_THERMAL_EXPANSION**. It only worked for solid ELFORM = 0, but now it also works for other element formulations.
22. Added error trap for bad input to ***MAT_127**: variable N (number of statistical links) should be > 0.
23. Re-activate output files for ***MAT_135**: the manual mentions files Contour_1# etc. in Remark 2, but they have been output as empty files for many years. The files now contain data again. Also, added jobid to the file names.

24. Removed very old diagnostic write statements that could have potentially corrupted the deforce file in any model using ***MAT_WOOD** / ***MAT_143**.
25. Fixed implicit convergence problem for ***MAT_157_IHIS**.
26. Fix FLEXLM license checkout issue for ***MAT_161** and ***MAT_162** licenses that was broken some time ago. Also, changed the required environment variable which for some strange reason contained the license version number embedded in it, meaning it was different for every version of the code. Now these are set to ANSYS_LSMAT161 and ANSYS_LSMAT162.
27. Bug fix affecting ***MAT_172 (*MAT_CONCRETE_EC2)** with TYPEC = 1, 2, 4, 5, 7, or 8. For these settings of TYPEC, the mechanical properties of the concrete vary with temperature, in particular the compressive strength reduces with increasing temperature. When subjected to increasing temperature under confined/restrained conditions, there is a complex situation whereby the compressive stresses build up due to thermal expansion, but the compressive strength is reducing due to the effect of the increasing temperature on the mechanical properties. In this situation, the bug caused the compressive stress to build up more slowly than expected.
28. ***MAT_173 (*MAT_MOHR_COULOMB)** calculates a tensile pressure cut-off which is intended to occur at the stress state where the yield surface reaches zero shear stress. This was done correctly for friction angle $\text{PHI} > 0$, but when $\text{PHI} = 0$ (meaning purely cohesive behavior), the tensile cut-off was incorrectly set to zero. Now, an arbitrary very large tensile cut-off is applied when $\text{PHI} = 0$.
29. For materials ***MAT_173** and ***MAT_198**, curves used for these material were not being passed correctly for solid element form 62. If the curves were not in use, then these materials worked with this element formulation.
30. Fix for keyword input read of ***MAT_186**: variable TSLC2 was not working in free format or with ***PARAMETER**.
31. The table evaluation for the damage evolution parameter ($\text{UPF} < 0$) for solids / tshells on ***MAT_4a_MICROMECH** / ***MAT_215** was not correct.

32. Fix for initial temperatures in ***MAT_224** combined with ***LOAD_THERMAL**. Temperatures in hisvar #14 (solids) and #10 (shells) can be set with ***INITIAL_STRESS_SOLID/SHELL**. Simultaneous use of ***LOAD_THERMAL** on other parts in the model should not alter these values.
33. Updated ***MAT_244** to use the same Cowper Symonds expression as ***MAT_106**.
34. Modified plasticity algorithm for ***MAT_248** to be consistent with ***MAT_106**:
 - Strain rate effects are now formulated as plastic strain rates.
 - Updated to use the same Cowper Symonds formulation.
35. Bug fixes for Kirkaldy phase model in ***MAT_254**:
 - Corrected input for initial grain size.
 - Start transformation with a very small amount of the target phase
36. For ***MAT_255** added missing integration point coordinates needed for temperature.
37. Fixed combination of ***MAT_280** and ***PART_COMPOSITE**. Some history variables (1,2,3) are copied across thickness and that should not be the case for integration points with non-glass material.

§7.20 MPP

1. Fix for MPP startup issue that was introduced in R13.0. The bug would cause startup failure when running on multiple hosts and using a GLOBAL directory (pfile option directory { global <dirname> } that was not the same as the current working directory.
2. Fixed a couple of errors in the balancing of cross sections (***CONTROL_MPP_REBALANCE**) that were resulting in seg faults.
3. Added MPP rebalancing for **FORCE_TRANSDUCER** type contacts, which were not previously supported.
4. Fixed MPP rebalancing of cross sections which were not being treated properly when moving between processors.
5. Added MPP support for ***TERMINATION_BODY** which was never properly implemented in MPP.

§7.21 Multiscale

1. Solved the MPI traceback issue in two-scale cosimulation (***INCLUDE_COSIM**).
2. Fixed issue where one job may be hanging when the other one is terminated for two-scale cosimulation with ***INCLUDE_COSIM**.

§7.22 Output

1. Update to MPP handling of the `disbout` data in the LSDA output file `binout` which was not properly accounting for elements that have failed. This resulted in incorrect data being output for `disbout` once the first element being output failed. SMP did not have this problem.
2. Fixed bug that caused shell data to be skipped in the `d3thdt` output routines. It resulted in corrupted `d3thdt` files.
3. Add missing initialization which could result in memory allocation problems for PGI binaries running models with thick shells output to the `e1out` file.
4. Fix thermal-only call to write out `curvout` file in LSDA format. It was only calling the output routine if the ASCII version was requested.
5. Fixed mistake in the `e1out` output routine introduced in R13.0. It could result in a seg fault in problems with thick shell output to `e1out` when strain data output is turned off.
6. Fixes for data output for simulations with in-core adaptivity (***CONTROL_ADAPTIVITY**):
 - Fixed issue with `intfor` file rotation (the new sets of files created after each adaptive step). This issue could cause an incorrect interface count in the file header for `intfora` which caused all the remaining files to be read incorrectly.
 - Fixed `intfor` data output issue that led to the element data being in the wrong locations.
 - Fixed issue with `d3plot` file rotation. The issue could cause incorrect material types in the file header.
 - Fixed `d3plot` data output issue that produced bad `d3plot` files if any of the elements in the model eroded.

7. d3dr1f did not contain failure flags. Thus, deleted elements did not disappear when animating the model during post-processing.
8. Fixed bug in ***DATABASE_HISTORY_NODE_SET** if i10 format is used (i10=yes on the command line).
9. Full deck restart d3plot output times differed depending on whether MPP or SMP was used. They now match.
10. Fixed a bug in the normal force output for 2D belts. The results were incorrect.
11. Fixed an MPP bug for ***DATABASE_RECOVER_NODE** that occurs for solid elements with more than one integration point. The results were incorrect.
12. Fixed a bug for 2D belts that mistakenly turned off output to d3plot for regular 1D belts when IP1DBLT = 0.
13. LS-DYNA was not printing belt results (***DATABASE_HISTORY_SEATBELT**) for the specified elements.
14. Fixed issue in ***DATABASE_SECFORC** that caused SECFORC force to be too large. This issue occurred for MPP with more than one cpu.
15. Enable ***DEFINE_MATERIAL_HISTORIES** to be used with Rayleigh damping. The history data and damping variables were conflicting, causing early failure of elements.
16. The d3thdt file (see ***DATABASE_BINARY_D3THDT**) was corrupt if NINTSLD = 8 on ***DATABASE_EXTENT_BINARY**. Element stress output to elout and binout files was unaffected by the bug.
17. Stresses for elements made of ***MAT_FABRIC** should not be written to the ***INITIAL_STRESS_SHELL** cards in the dynain file. This was done correctly for dynain files triggered by the ***INTERFACE_SPRINGBACK** card, but not for dynain files triggered by the staged construction keywords (see ***CONTROL_STAGED_CONSTRUCTION** and ***DEFINE_CONSTRUCTION_STAGES**).
18. When using SLDO = 1 on ***INTERFACE_SPRINGBACK**, for some anisotropic material models, the requested ***ELEMENT_SOLID_ORTHO** was not written properly.

19. Failed elements were not being properly skipped for the SSSTAT output (***DATABASE_SSSTAT**) and could cause errors.
20. For ***DEFINE_MATERIAL_HISTORIES**:
 - Fixed incorrect number of material histories being output. One too many was output with the result of the last one being nonsense.
 - Fixed output of history variables when ***DEFINE_MATERIAL_HISTORIES** is used with ***MAT_FABRIC (*MAT_034)** to make sure that transformation quantities stored among history variables are not affected or affecting results.
21. Fixed output of extrapolated solid stresses for solid element -18. It was incorrectly assumed that the number of integration points were one too many; see SOLSIG on ***DATABASE_EXTENT_BINARY**.
22. For ***DATABASE_D3MAX**, fixed bugs in the single precision versions which caused crashes in MPP runs and 0 von Mises stress in SMP runs.

§7.23 Restarts

1. Fixed reading of Full Deck Restart in MPP which was broken for inputs having ***CONTACT_AUTOMATIC_GENERAL**. This has been broken since January of 2019.
2. Fixes for ***DATABASE_BINARY_INTFOR** and full deck restart:
 - SMP was opening the new file with the wrong “max file size” during restart, causing problems reading the data in some cases.
 - MPP was opening the new file without the “ab” family extension, and overwriting the files from the initial run.
3. Fixed issue causing eIout files to be missing after restarts. It was most likely broken in R13.0.
4. Pore fluid analysis (see ***CONTROL_PORE_FLUID**) did not work with full-deck restarts.

§7.24 Sensors

1. Fixed a bug for FTYPE = X-SECFORC of ***SENSOR_DEFINE_FORCE**. It occurred when the related ***DATABASE_CROSS_SECTION** was not defined. The bug was leading to a seg fault.

2. Fixed an MPP bug for TYPE = CNRB on ***SENSOR_CONTROL**. It occurred when a core did not own any part of the rigid body.
3. Fixed an MPP bug for FTYPE = SPC on ***SENSOR_DEFINE_FORCE**. The results were incorrect when more than one core was used.
4. Fixed a bug for ***SENSOR_CONTROL** that occurred when TYPE = ELESET and ESTYP = DISC. The bug caused discrete elements to not be deleted as designed.
5. Fixed the use of ***INCLUDE_TRANSFORM** with ***SENSOR_DEFINE_FORCE** when TYPEID = X-SECTION, CONTACT, CONTACT2D, JOINT, JOINTSTIF, RWALL or SPC and ID offsets are used for the transformed parts.

§7.25 SPH

1. Fixed bug in neighbor search calculation for SPH that manifests when the model switches from implicit to explicit time integration. Previously, the neighbor list was never updated.

§7.26 Thermal Solver

1. Added parameter VARDEN from ***CONTROL_THERMAL_SOLVER** to d3hsp.
2. Fixed bug in the thermal solver for ***CONSTRAINED_ADAPTIVE** for constrained solid / beam nodes in case thermal thick shells are also present in the model. This bug could lead to LS-DYNA crashing.

§7.27 Miscellaneous

1. Added warning if an ***INTERFACE_LINKING** interface cannot be found in the interface file from the previous run.
2. Fix indexing error related to ***SET_SEGMENT_GENERAL**. It could have resulted in incorrect values being applied for the DA1-DA4 parameters, or possibly a seg fault during input processing.
3. Fixed bug in ***TERMINATION_DELETED_SOLIDS**. The simulation was sometimes continuing to run even though the termination criteria was met.

4. Fixed memory allocation issue that was causing memory errors on some models with unusually large ***DEFINE_FUNCTION** definitions.
5. Character parameters (see ***PARAMETER**) were not conforming to the usual convention for comma-delimited input.
6. Fixed bug for ***PARAMETER** if long format is used.
7. Check ***PART** type and ***ELEMENT** type against the formulation defined in ***SECTION**.
8. Fixed bug when using a character parameter (see ***PARAMETER**) in a larger string as part of an include file name. The bug caused an extra space in the file name which led to an error termination.
9. SMP versions seg fault when a file with a long filename is in the working directory. The error occurred when the length of the filename is at least 188 characters.
10. For ***DEFINE_CURVE_FUNCTION**,
 - Fixed a bug for PIDCTL that occurs during thermal-only analyses and results in an erroneous PID control force.
 - Fixed a bug for SENSOR or SENSOR.D. The curve value at the last step, not the current step, was being output.
11. For ***INCLUDE_TRANSFORM**,
 - Fixed a bug that happens when the included file has ***PART_INERTIA** or ***CONSTRAINED_NODAL_RIGID_BODY_INERTIA**. The bug was leading to an incorrect warning message.
 - Fixed bug that occurs when discrete elements and the related materials or sections are not defined in a single included file. It was leading to an error termination.
 - Fixed a bug for the POS6N option of ***DEFINE_TRANSFORM**. The model was not correctly transformed.
12. Fixed a bug for ***NODE_TRANSFORM** and ***SET_NODE_GENERAL**. It occurred when BOX or VOL was used for ***SET_NODE_GENERAL** in a model that also included ***NODE_TRANSFORM**. The nodes were not being transformed correctly.
13. Fixed issue where ***MODULE_USE** did not work correctly for user material numbers in the extended range 1001 to 2000.

14. Fixed issue where defining shared object file paths through ***MODULE_PATH** or LD_LOAD_LIBRARY_PATH did not work correctly.
15. ***MODULE_LOAD** or the command line option "module=" could not be used with the default usermat shared object filename.
16. Fixed issue where users were barred from using the user material subroutines umat42, umat48v, and umat49v.
17. Fixed issue in ***DEFINE_PRESSURE_TUBE** where automatic generation of type 25/26 shells did not work.
18. Fixed ***RIGIDWALL** code to prevent memory errors in very large models. Small models were working.
19. Fixed bug in reading back input data for ***RIGIDWALL_PLANAR_MOVING** from structured file in case of long = s. Mass and velocity were not being read back correctly.
20. Avoid misinterpretation of OPTCARD on ***PART_COMPOSITE** as a label.
21. Fix for ***DEFINE_DE_ACTIVE_REGION** with TYPE = 1 (box) and long=s: coordinates were read in the wrong format from the structured input.