Spring, 2011

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DEFORM™ News

Events:

- May 23-25, 2011: SFTC will exhibit DEFORM at Aeromat 2011 in Long Beach, California.

Training:

- June 7 & 8, 2011: DEFORM-2D training (includes DEFORM-F2) will be conducted at the SFTC office.
- June 9 & 10, 2011: DEFORM-3D training (includes DEFORM-F3) will be conducted at the SFTC office.
- August 2 & 3: DEFORM-2D training (includes DEFORM-F2) will be conducted at the SFTC office.
- August 4 & 5: DEFORM-3D training (includes DEFORM-F3) will be conducted at the SFTC office.

DEFORM™

Design Environment for FORMing

Understanding Flow Stress

Material flow stress data is the basis for all forming simulations in DEFORM. Flow stress data defines the basic strength of the material. It also captures work hardening, softening with increasing temperature, and other changes in strength that occur during the forming process.

Flow stress is a measure of the forming pressure required to cause permanent deformation in the material being formed. The value varies from point to point within a workpiece. It evolves with changing temperature, strain hardening, flow softening and forming rate. At the physical level, changes in flow stress result from changes in the microstructure of the material. In DEFORM, these changes are represented by equations or tables of data.

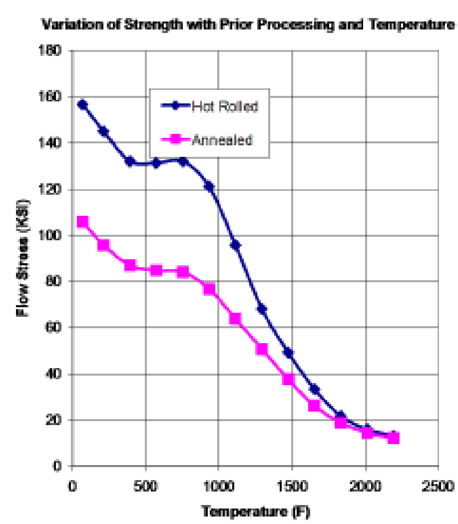
If the flow stress data is not representative of the material being simulated, the predicted loads may be too high or too low. Metal flow behavior can be incorrect. In particular, certain types of defects may be missed, especially those involving flow localization.

The flow stress of a material is determined by the type of material, its history and processing conditions. For a given base metal (aluminum, iron, titanium), alloying elements generally add varying degrees of strength to the material. Deformation conditions, including amount of deformation (strain), speed of deformation (strain rate) and temperature contribute very significantly to the flow stress. Prior processing history can also have a strong influence on flow stress, particularly at lower forming temperatures. As forming temperature increases, the influence of processing history tends to decrease. Although in some materials, there is still significant history dependence at hot forging temperatures.

Flow stress is measured by holding a sample of known size between a fixed and a moving tool, heating it to a known temperature and deforming it at a controlled speed. The force required for various rates and amounts of deformation is recorded. The force and deformation are converted to true stress, true strain and true strain rate. DEFORM requires flow stress curves be provided at a constant temperature for a given curve. During testing, the temperature of the sample generally increases due to deformation heating. By estimating the heat generated during testing, temperature corrected curves can be derived from test data. DEFORM support staff can provide spreadsheets and assistance in converting measured test data to a format suitable for DEFORM.

It is important that flow stress data cover the same temperature and strain range as the process being simulated.

The DEFORM material library contains hundreds of materials taken from published sources. Much of the data comes from metal forming research at Battelle Laboratories. Other sources are documented in the comments in the library files.



Because flow stress in cold forming is strongly history dependent, the best source of cold forming flow stress is testing the actual material to be formed, from the same supplier, and in the same anneal state that will be used in production. DEFORM support can provide a simple spreadsheet to convert yield and ultimate tensile strength (UTS) into flow stress. If yield and UTS are not available from the supplier, it can be obtained from a quick, simple, and very low cost tension test.

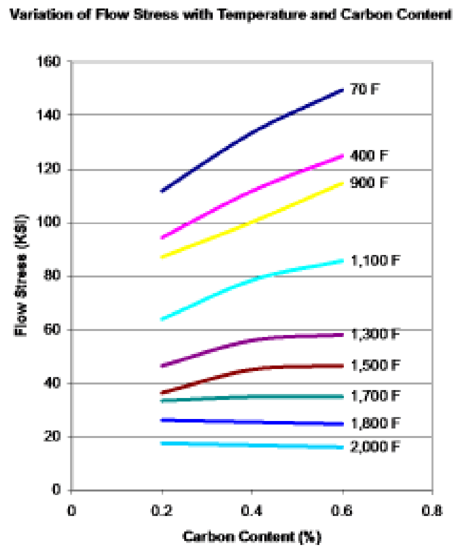
Testing at elevated temperatures is considerably more time consuming and expensive, generally requiring specialized equipment and experienced staff. However, since flow stress at elevated temperature is considerably less history dependent, it is often suitable to use data from published sources or simply use a similar material. SFTC may have access to some published data which has not yet been entered into the library, so a check with DEFORM support is a useful first step when searching for a material not in the library. Any data entered into DEFORM should be true stress – true strain, and corrected for deformation heating which occurs during testing.

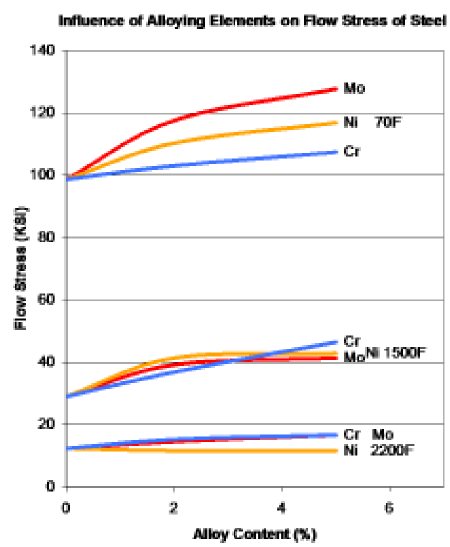
Many material suppliers have flow stress data which they will share with customers under a confidentiality agreement, but will not make available for general publication. Particularly for aerospace or other exotic materials, contact your supplier directly to see if they have information available.

There is some flow stress data published in journals or other scientific publications. A Google search on the material name and "flow stress" is a good place to start.

If data for your specific material is not available, a similar alloy will often yield acceptable results. In steels, carbon provides significant strengthening at low temperatures. However at temperature of 1650F (900C) and higher, carbon enters into a solid solution with iron, and offers almost no strengthening. For this reason, it is acceptable to ignore carbon content when searching for similar alloys at hot forging temperatures. A typical variation of flow stress with carbon content is shown in the figure above.

Aside from carbon, the most popular alloying elements for steel are Chrome, Vanadium, Molybdenum, Nickel and Manganese. The figure above shows the variation of flow stress with alloy content, and can be useful in estimating variations in strength.





Thermal and elastic properties are driven by the base material (iron, aluminum, titanium, etc) and are much less sensitive to alloy content, so substitution from a similar alloy is almost always acceptable.

If the alloy is too far from other available materials, or if there is a compelling need for very accurate material data (frequent use, or high cost project), testing is always an option. DEFORM support can suggest laboratories which will provide testing services.

As always, contact your local distributor or SFTC for assistance with any aspect of material model selection, modification, or implementation.

Releases:

DEFORM v10.2 (beta1) and v11.0 (beta) were posted for distributors the 2nd week of April 2011. Beta2 updates for users are planned for May 15th and the official release before the end of June 2011 (subject to internal testing).

System improvements included in DEFORM v10.2 and v11.0 (beta) are:

- Upgrade to MPICH2 for improved 64 bit performance in multi-core PC's
- 64 bit user subroutine support in Windows and Linux
- Improved batch queue stability in Linux
- Shape morphing and parametric design features included in 3D geometry tool
- 2D to 3D translation handles multi-phase transformation data
- PATRAN data file format importer
- Dual frequency induction heating in DEFORM-2D

In version 11.0 Beta (optional install with 10.2 release):

- Enhanced 3D extrusion simulation
- Mesoscale microstructure / material model
- 2D torsion mode now supports elastic-plastic materials
- Integrated 2D-3D machining distortion model

OS Support notes: System support for HP-UX 11.23, HP-UX 11.0, HPXC Linux and Suse92 Linux is limited to bug fixing. No 64 bit 3D FEM engine support is available.

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