

# Software for Creating LS-DYNA® Material Model Parameters from Test Data

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**DatapointLabs**

technical center for materials

+

**matereality**  
a DatapointLabs affiliate

EST 1995

ISO  
17025  
Quality



# Materials

Testing x Software x Data Infrastructure



**DatapointLabs**

strengthening the materials core of manufacturing enterprises

**matereality**

# Using LS-DYNA Material Models

- Select right model
- Obtain the right material data
- Convert material data to material parameters
- Set flags and model features
- Write correct material file
- Perform validation if needed

# Conversion Philosophies

- **General optimization**
  - Float parameters over entire data space
  - Good for difficult models without well reasoned experiments
  - Can produce non-physical outcomes ☹️
  - Validation is required
- **Direct conversion**
  - Mathematical transforms and visual aids
  - Regression may be used to fit specific model components, e.g. Cowper Symonds
  - Model fit can be checked against test data

# LS-DYNA CAE Modeler<sup>2</sup>

- Based on direct conversion philosophy
- Extension of previous work with MAT\_024
- On Matereality's private cloud/server solutions



— Parameter conversion software



— Materials library



— Material property library



— Material model library

# Conversion Process

- Upload test data
- Run CAE Modeler
- Save model files in Material Model Library

# Getting Started

Home - MyMatereality x

serverthree/test/Matereality/MyMatereality/

matereality

Home Settings Logout  
Confidential Demo Purposes

Global Data Center

My Workgroup

My Database

GridView My Properties Workgroup Properties Manage Users Messages Activity Tracker

Design Data CAE Modeler Material Model Library Data Loader Free Databases My Materials

Workgroup Materials

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Start with this app

# Define the material

Define material

matereality

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Materials Information

Showing Materials 1 - 10 of 49

Processing Composition

1100-H12

3 MM Linaplus Ozone (Black) 35 Shore A

300M

8529K13 NYLON 66

8586K162 ABS

8619K441 HDPE

8742K133 PP

8752K111 UHMWPE

9266K14-DTFF

Define New Material

Name AP7810

Class Plastic Subclass PP

Manufacturer Ink

Specifications Insulation  
Liquid  
Lubricant

Processing Metal

Applications Mineral

MSDS Url

DataSheet Url

Notes

Save

Keywords

Color

Provide material name and classification



# Add tensile properties

Matereality

serverthree/test/Matereality/MyMatereality/MyDatabase/Materials

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Search Tools

### Materials Information

Matereality > Database Builder > Properties - Google Chrome

serverthree/test/Matereality/MyMatereality/Legacy/DataLoader/PropertySummary.aspx

AP7810A > Unknown Property

database builder

Test Manager

**Data Loading Wizard**

**Project Information**

Project ID: 36b68b78

Purpose:

**Select Property**

Property: Tensile Properties

press ESC to cancel this wizard.

Next

ISDS Datasheet Properties CAE Models

Add properties

Choose Tensile Properties

# Drop in rate dependent data

The screenshot shows the 'Test Manager' window in a web browser. It contains three test configurations, each with a 'Variables' section and a 'Replicates' section. The 'strain rate' values are 1, 10, and 100 for Test 1, Test 3, and Test 4 respectively. The '10' value in Test 3 is circled in orange. A yellow callout box on the left points to this value with the text 'Enter strain rate'. Another yellow callout box on the right points to the 'Delete' button of Test 1 with the text 'Cut and paste stress-strain data for each strain rate'. The browser title bar reads 'Matereality > Database Builder > Properties - Google Chrome' and the address bar shows 'serverthree/test/Matereality/MyMatereality/Legacy/DataLoader/PropertySummary.aspx'.

Enter strain rate

Cut and paste stress-strain data for each strain rate

# Using CAE Modeler

Home - MyMatereality x

serverthree/test/Matereality/MyMatereality/

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Home Settings Logout  
Confidential Demo Purposes

Global Data Center

My Workgroup

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Design Data CAE Modeler Material Model Library Data Loader Free Databases My Materials

Workgroup Materials

Choose this app

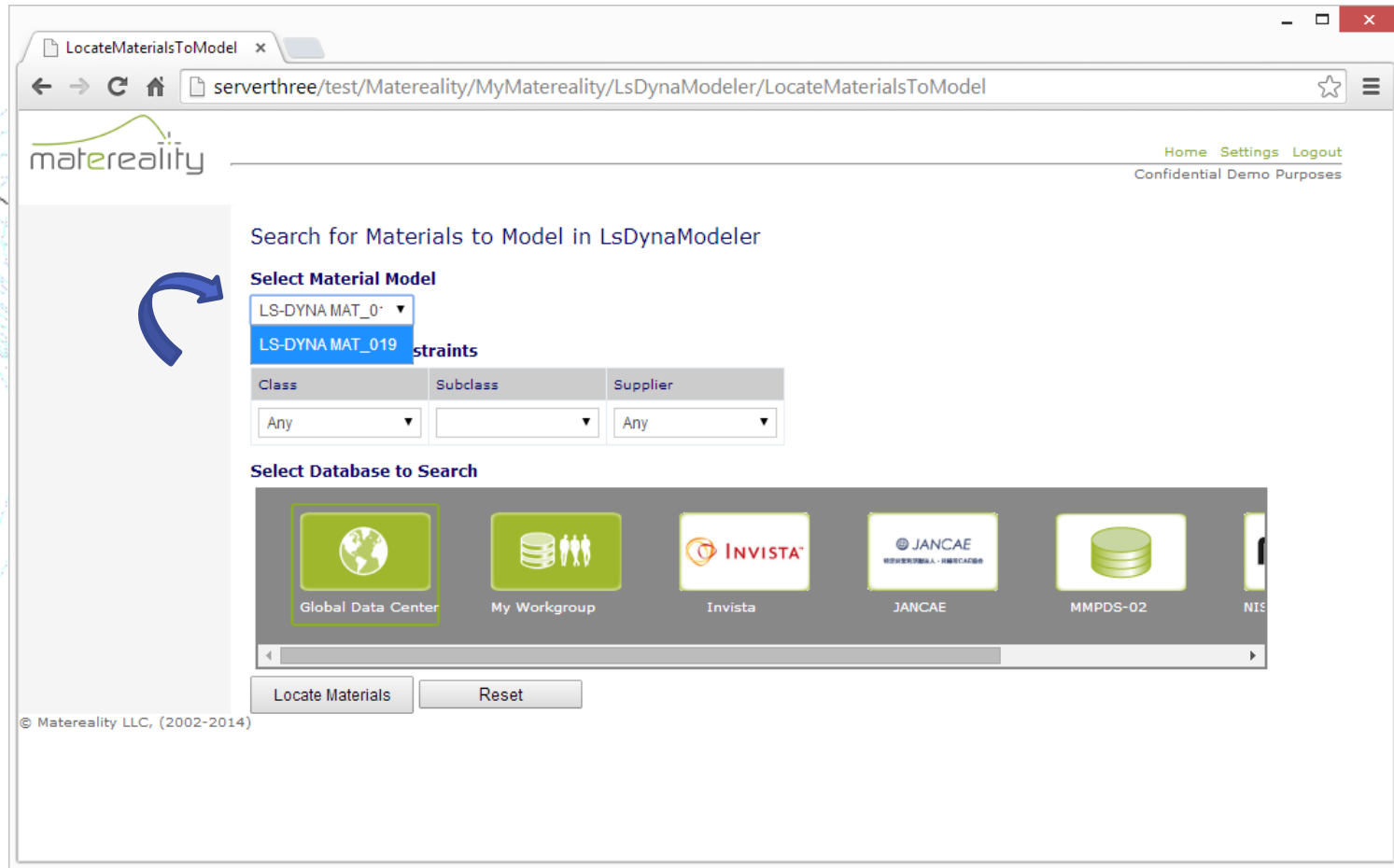
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# Sending data to CAE

- CAE Modeler slices multivariate data into CAE-consumable slices
- Converts material data to model parameters
- Writes files to Material Model Library

The screenshot shows the Matereality web application interface. At the top, there is a navigation bar with 'Home', 'Settings', and 'Logout' links, and a note 'Confidential Demo Purposes'. Below this, there are sections for 'Global Data Center', 'My Workgroup', and 'My Database'. A central area contains several icons for different tools: GridView, My Properties, Workgroup Properties, and Tracker. A yellow callout box with the text 'Pick LS-DYNA CAE Modeler' has a blue arrow pointing to the LS-DYNA icon in the 'Create Models for your CAE' section. This section lists various CAE software options: SIMULIA (Abaqus/CAE), Autodesk Simulation Mechanical (Algor), ANSYS, LS-DYNA, Moldex3D, Autodesk Simulation Moldflow, SIEMENS NX Nastran, esi get it right\*, ES1 PAM-CRASH, Simpo, and SOLIDWORKS. A green callout box next to the SOLIDWORKS icon contains the text: 'Locate data for SolidWorks studies and create material models for direct input into SolidWorks. Matereality runs within SolidWorks 2014.' The footer of the interface includes the copyright notice '© Matereality LLC, (2002-2012)'.

# Select desired material model



The screenshot shows a web browser window with the URL `serverthree/test/Matereality/MyMatereality/LsDynaModeler/LocateMaterialsToModel`. The page title is "LocateMaterialsToModel". The Matereality logo is in the top left, and navigation links for "Home", "Settings", and "Logout" are in the top right, along with the text "Confidential Demo Purposes".

The main content area is titled "Search for Materials to Model in LsDynaModeler". Under the heading "Select Material Model", there is a dropdown menu currently showing "LS-DYNA MAT\_019" (previously "LS-DYNA MAT\_0"). Below this is a table with columns "Class", "Subclass", and "Supplier". The "Class" dropdown is set to "Any".

Under the heading "Select Database to Search", there is a horizontal carousel of database options: "Global Data Center" (highlighted with a green border), "My Workgroup", "Invista", "JANCAE", "MMPDS-02", and "NIS".

At the bottom of the form are two buttons: "Locate Materials" and "Reset".

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# MAT\_019 candidate materials

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Material	Property	Value	Unit
Match 1 AP7810	Tensile Strain at Break	0.0796	unitless
	Tensile Strength at Break	2.94E+07	Pa
	True Tensile Stress-Strain Curves		
Epitech ABS-803-701 black, Lot J504	Engineering Tensile Stress-Strain Curves		
	Offset Yield Strain in Tension	2.99	unitless
	Offset Yield Stress in Tension	2.49E+07	Pa
	Tensile Strain at Break	0.0855	unitless
	Tensile Strength at Break	3.28E+07	Pa
	True Tensile Stress-Strain Curves		
	Engineering Tensile		

crosshead speed 1.8E+04mm/m

serverthree/test/Matereality/MyMatereality/LsDynaModeler/ChooseResults?resultIds=872991%2C872989%2C873159%2C873043%2C873091%2C873044%2C872992%2C873042%2C873162%2C873...

# MAT\_019 card

CAEmodeler AP7810 > Ls-Dyna MAT\_019

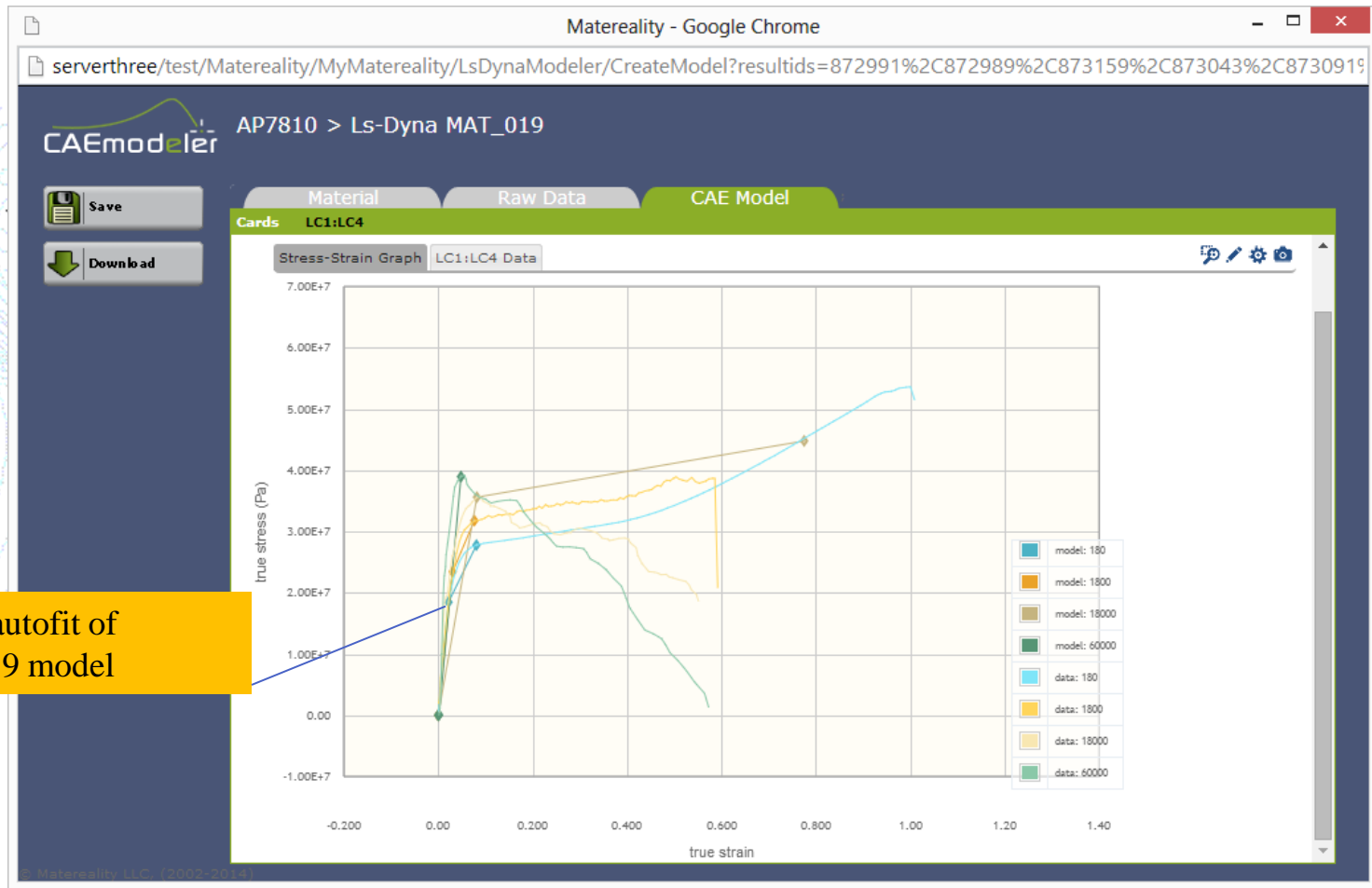
Material Raw Data CAE Model

Cards LC1:LC4

MID	RO (kg/m3)	E (Pa)	PR	VP	TDEL	RDEF
1000		845760687.436102	0.4	0.0		
LC1	ETAN	LC2	LC3		TDEL	RDEF
1000	157555152.10748082	1001	1002	0.0	0	0.0

Set flags and model features, e.g. Visco-plasticity

# MAT\_019 load curves





# Manual tuning of MAT\_019 model



# MAT\_019 LC1:LC4

Save model file

CAEmodeler AP7810 > Ls-Dyna MAT\_019

Material Raw Data CAE Model

Input Deck Tables & Curves

Stress-Strain Graph Load Curve Table Data

Strain Rate	LC1: Yield Stress (Pa)	LC2: Youngs Modulus (Pa)	LC3: Tangent Modulus (Pa)
0.1	26148648.64864865	557173376.8470553	22182227.711907957
1	29880067.56756757	739993684.6329628	20413790.135979895
10	32841216.216216218	1149543373.5662336	43553898.69562015
50	36782094.5945946	2018978673.3078425	55227350.938942395

Computed yield stress, Young's modulus, tangent modulus and failure stress

# Material Model Library

You can also upload externally created model files

My Material Model Library

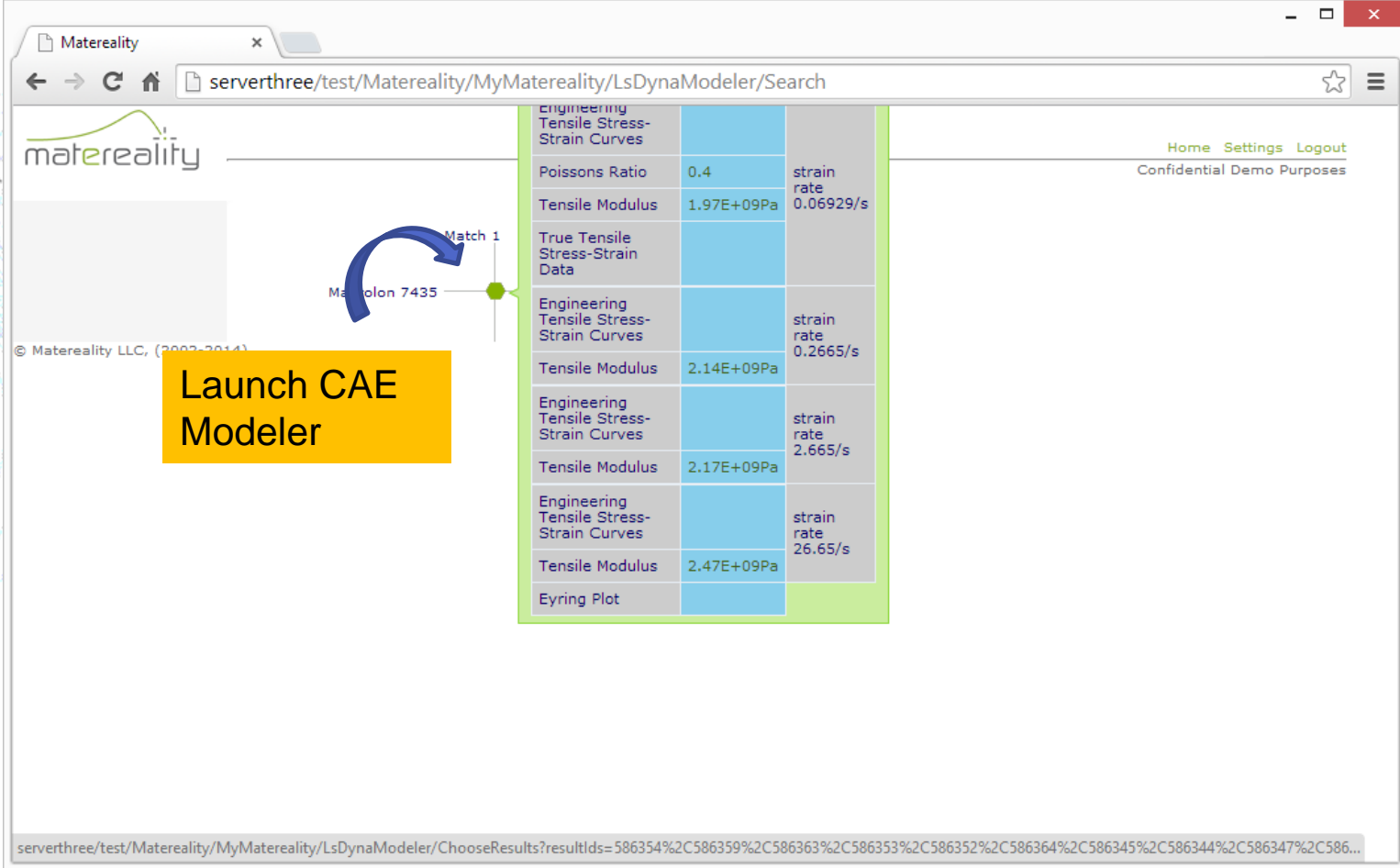
Display 10 Search: [ ] [First] [Previous] [1] [2] [3] [4] [5] [Next] [Last]

	MaterialName	ModelName	Format	Created	Notes
↓	Schwartz	ANSYS Elastic	ANSYS Workbench 14	12/18/2013 1:55:33 PM	This should work
↓	EPDM 60 Durometer	ANSYS Hyperelastic	ANSYS Workbench 12	12/11/2013 2:36:39 PM	Fit to 50% strain
↓	EPS Bead Foam	Abaqus Elastic	Old - ANSYS Workbench	12/13/2013 12:37:36 PM	
↓	8752K111 UHMWPE	ANSYS MISO	ANSYS Workbench 13	5/4/2011 9:57:12 AM	
↓	Delrin 8753K13	ANSYS Elastic	Old - ANSYS Workbench	3/18/2011 11:42:16 AM	
↓	Makrolon 7435	MAT_024 LCSS	LS-DYNA MAT_024 LCSS	8/9/2013 1:02:13 PM	cowper symonds first test save
↓	SANTOPRENE 55 Durometer	ANSYS Hyperelastic	ANSYS Workbench 13	11/7/2011 3:03:33 PM	
↓	LATEX 40 Durometer	Solidworks Hyper	Solidworks	12/17/2012 12:29:34 PM	
↓	8539K13 NYLON 66	SolidworksPlasticity	Solidworks	10/16/2012 10:34:12 AM	
↓	Durethan A 30	ANSYS Elastic	ANSYS Workbench 13	4/29/2011 9:33:52 AM	

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Model file is saved to Material Model Library. Model can be downloaded or refit from here

# MAT\_089 candidate materials



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Engineering Tensile Stress-Strain Curves		strain rate 0.06929/s
Poissons Ratio	0.4	
Tensile Modulus	1.97E+09Pa	
True Tensile Stress-Strain Data		
Engineering Tensile Stress-Strain Curves		strain rate 0.2665/s
Tensile Modulus	2.14E+09Pa	
Engineering Tensile Stress-Strain Curves		strain rate 2.665/s
Tensile Modulus	2.17E+09Pa	
Engineering Tensile Stress-Strain Curves		strain rate 26.65/s
Tensile Modulus	2.47E+09Pa	
Eyring Plot		

serverthree/test/Matereality/MyMatereality/LsDynaModeler/ChooseResults?resultIds=586354%2C586359%2C586363%2C586353%2C586352%2C586364%2C586345%2C586344%2C586347%2C586...

# MAT\_089 card

Materality - Google Chrome

serverthree/test/Materality/MyMaterality/LsDynaModeler/CreateModel?resultids=586354%2C586359%2C586363%2C586353%2C586352%2C586355%2C586357%2C586358%2C586356%2C586351%2C586354%2C586359%2C586363%2C586353%2C586352%2C586355%2C586357%2C586358%2C586356%2C586351

**CAEmodeler** Makrolon 7435 > Ls-Dyna MAT\_089

Material Raw Data **CAE Model**

Save Download

CAE Model

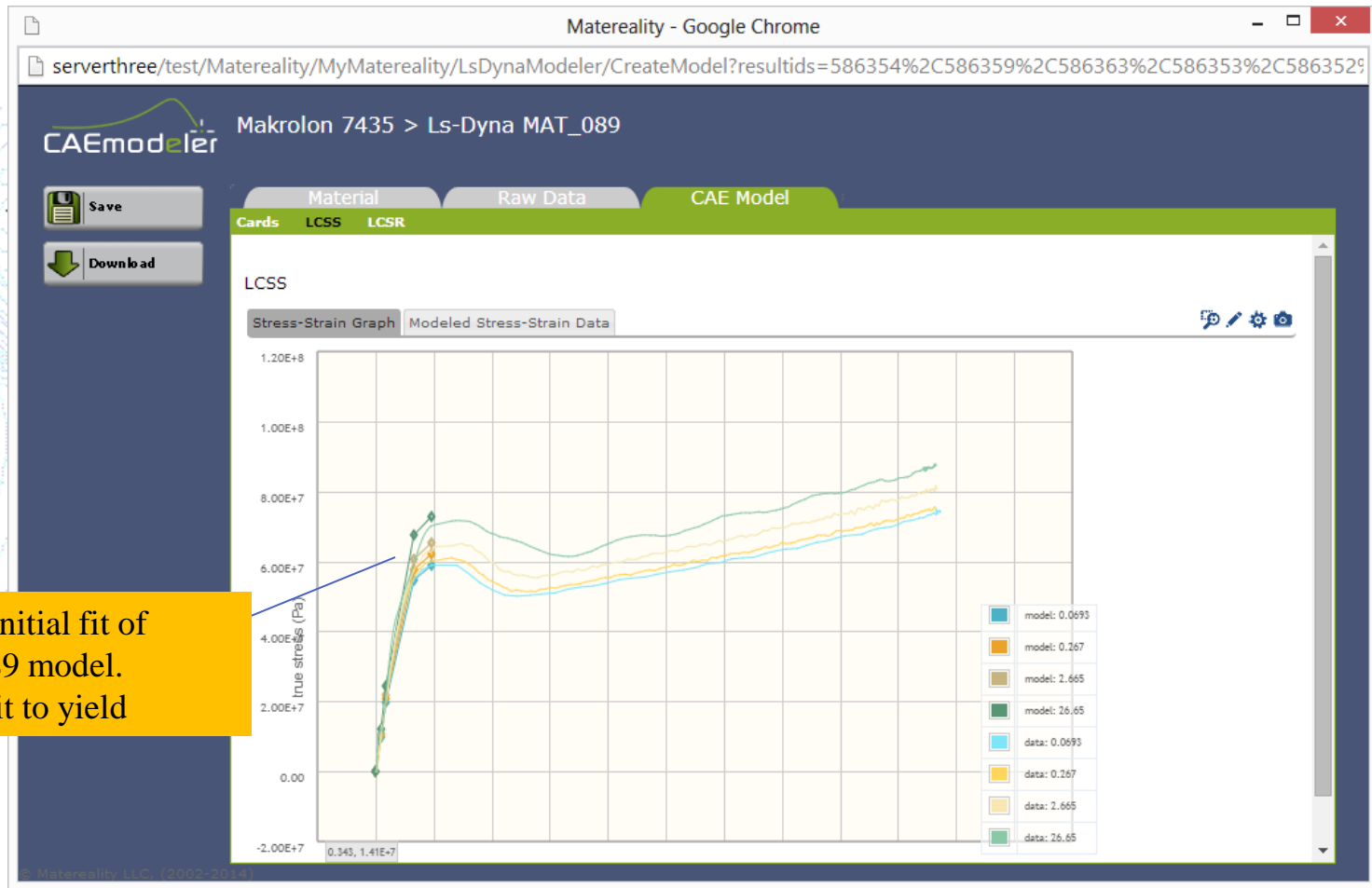
Cards LCSS LCSR

Cards

MID	RO (kg/m <sup>3</sup> )	E (Pa)	PR			
I13208	1200	1967000398.20387	0.4			
C	P	LCSS	LCSR			
0	0	1000	1001			
EFTX	DAMP	RATEFAC	LCFAIL			
0	0	0	1002			

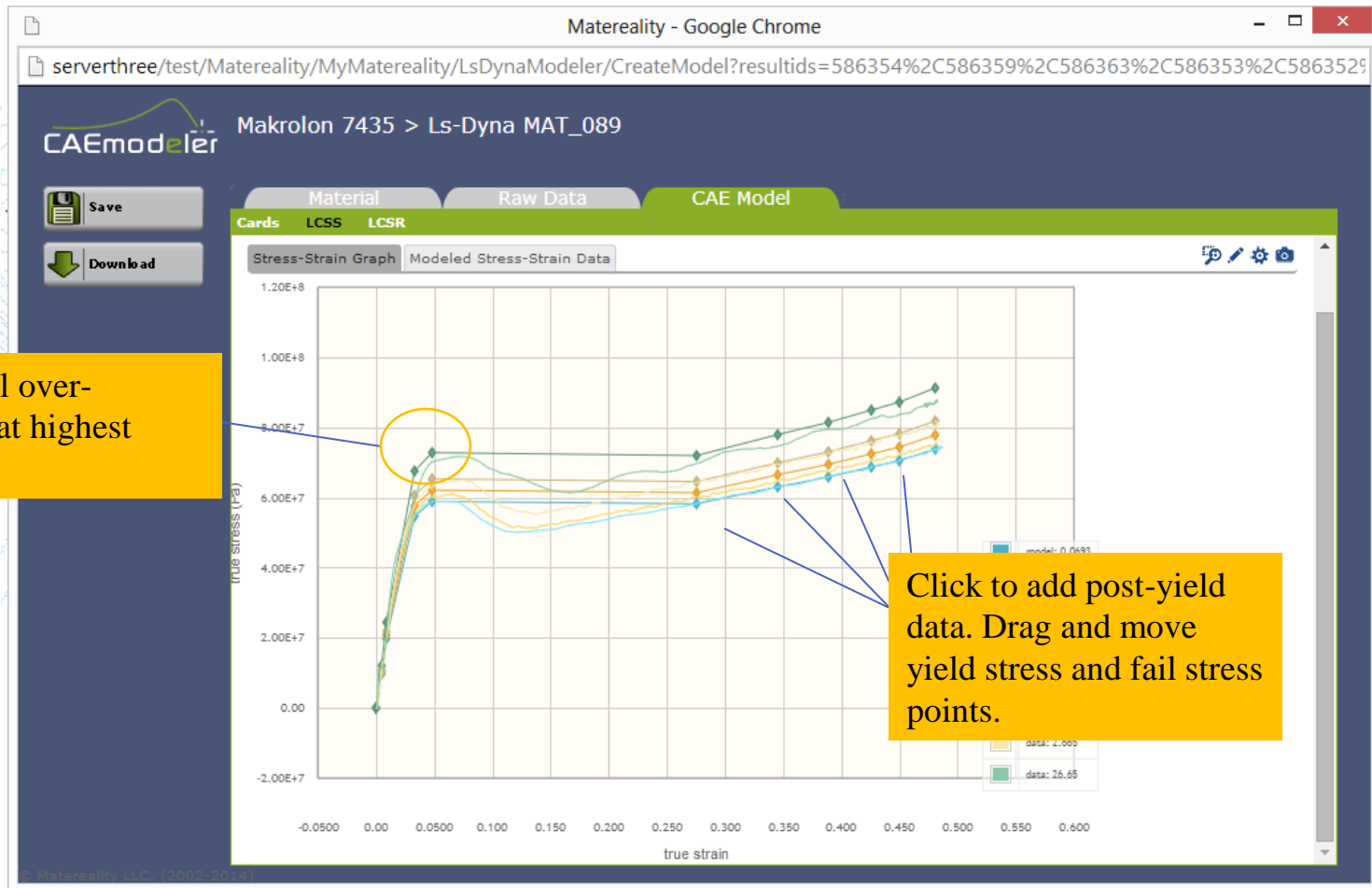
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# MAT\_089 LCSS load curve



Default initial fit of  
MAT\_089 model.  
Data is fit to yield

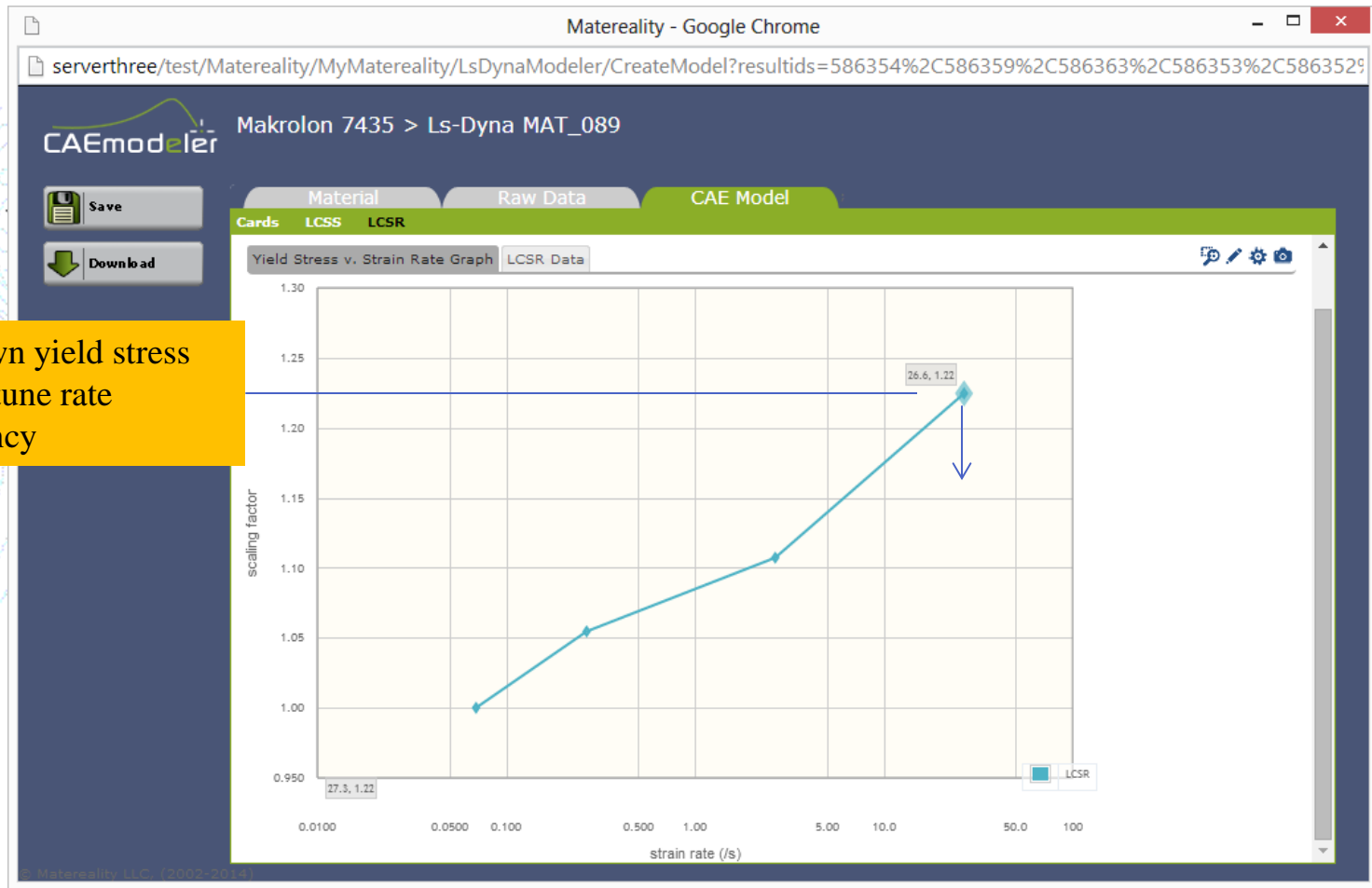
# Adding post-yield data



Note model over-prediction at highest strain rate

Click to add post-yield data. Drag and move yield stress and fail stress points.

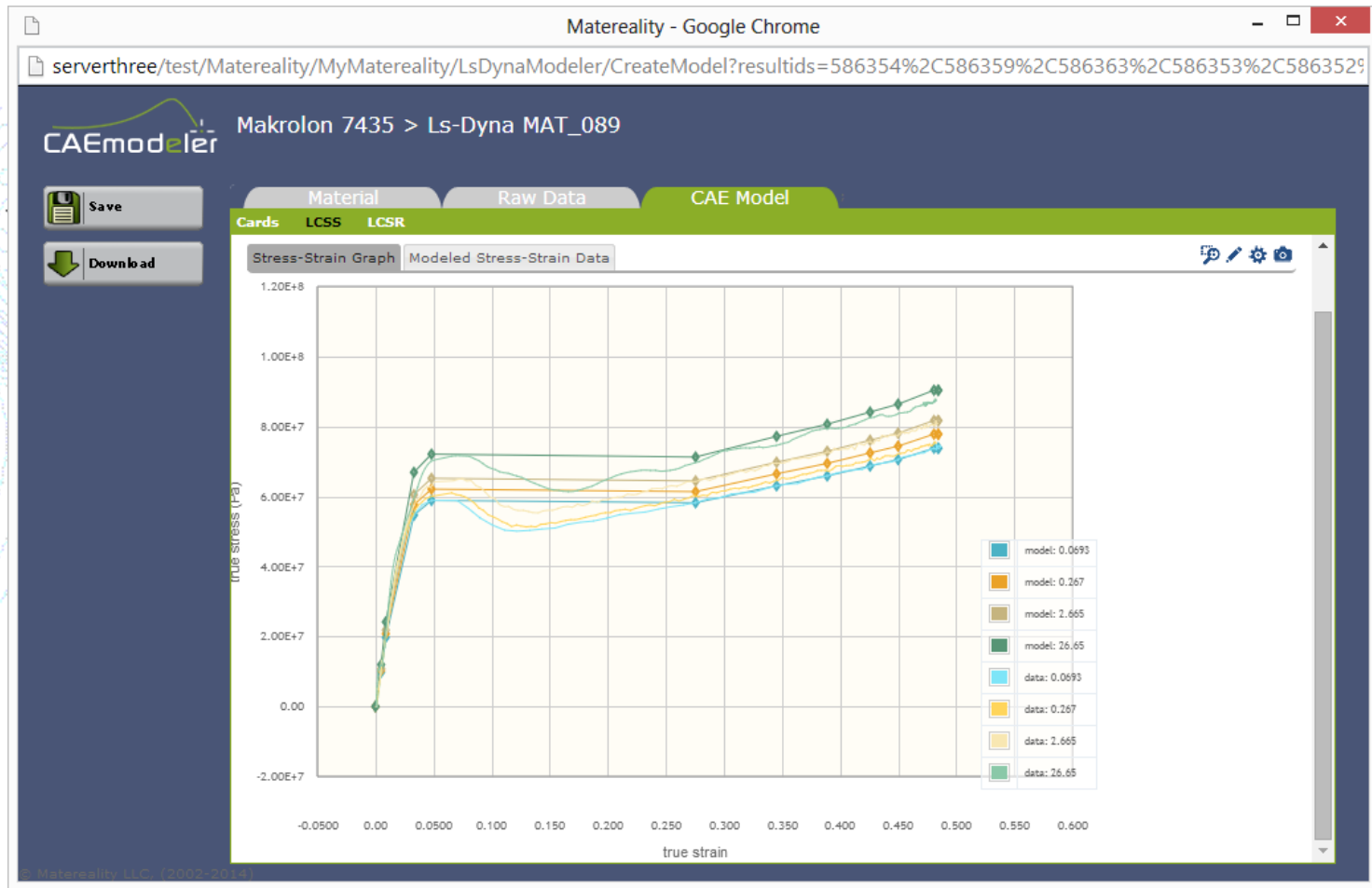
# Tuning rate dependency



Drag down yield stress ratios to tune rate dependency



# Tuned MAT\_089 model



# Conclusions

- Software for creating LS-DYNA material cards from raw data
- Includes material data and material card libraries
- Cards can be validated for greater reliability
- Extends previous work with MAT\_024
- Now includes MAT\_019 and MAT\_089

# Future Work

- Extension to other popular LS-DYNA models
  - Fu Chang Foam MAT\_083
  - Crushable foam
  - Rubber Hyperelastic MAT\_027
  - Visco-elastic
  - SAMP-1