Datapoint

Reporting on developments in material properties for engineering design

E-COMMERCE

Streamlining the ordering process

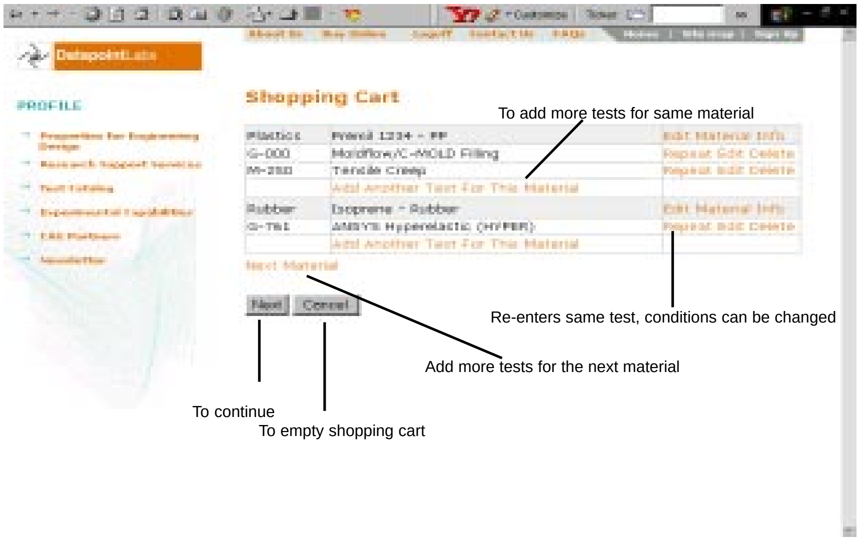
One of the primary objectives of the e-commerce site datapointlabs.com is to streamline the order-placement process for testing materials and convey the client's instructions seamlessly to the lab personnel performing the test. The advantages are clear: tests performed unambiguously, on time, and delivered in the format requested by the client. However, to transcribe the complex requirements for material properties testing into an experience analogous to buying at a retail site online was a major challenge.

With the help of a few dedicated customers, DatapointLabs has been testing - its own e-commerce site www.datapointlabs.com, for over a year. It has recently updated this site to make placing orders online as simple as walking down the corridor to your laboratory with your instructions. Except! You don't need to leave your desk. The site now delivers instant customized quotes, allows order placement, status monitoring and billing.

As with all purchases, there is no one else who knows exactly what you need better than you. To help you make the right test selection and remember all the conditions you need to specify before we test, the site is designed to prompt you with questions and provide guidelines for each test.

A short tour of shopping online:

- Log on with your User ID and password. Quotes, current and past orders are now accessible.
- Buy Online on the top menu bar leads to the catalog.
- Select tests by *TestPaks*™, test type, or search the catalog by keyword, ISO or ASTM standards.
- Click on a test title to see more details.
- Click on the Price button: pre-filled instrument and standards information prompts you to enter the desired test conditions. Prices are computed automatically based on choices made. Need help? Call 1-888-DATA-4-CAE.
- Enter the material identification.
- Your desired test is listed in the shopping cart. Need more tests for the same material, or repeat the same test under different conditions? Need same list of tests for multiple materials? Tools allowing you to quickly add tests (as shown below) aid the order placement process.
- Hit Next to obtain a quote, enter billing details, or place an order.
- Access your order online and edit it anytime before start of testing. Automailers keep you informed of work status.
- You can access and print your quote, order or invoice at any time for your records.



Shopping Cart

Plastics	[illegible] 1234 - PP	Edit Material Info
G-000	Moldflow/C-MOLD Filling	Repeat Edit Delete
M-250	Tensile Creep	Repeat Edit Delete
	Add Another Test For This Material	
Rubber	Isoprene - Rubber	Edit Material Info
G-T61	ANSYS Hyperelastic (HYPER)	Repeat Edit Delete
	Add Another Test For This Material	

Next Material

Next Cancel

FOCUS:

E-commerce for material testing

This issue highlights the new features at www.datapointlabs.com: user-friendly tools such as shopping cart enable a quick and informed order to be placed online.

On page 2, read Benoit Debbaut's article that simplifies data gathering for blowmolding and thermoforming simulation. Casey Heydari presents a case study simulation of hydroplaning with MSC.Dytran (pg 3).

Refer to Page 2 for additions to our *TestPaks*™ Alliance Program (TAP), and our Engineering Team.

We continue to bring additional capabilities under our quality system as outlined below.

QUALITY SYSTEM

Accreditation scope widens

DatapointLabs maintains an active program to continuously add new tests to its A2LA Scope of Accreditation. Some of the latest additions are listed below:

ASTM D412: Vulcanized Rubber and Thermoplastic Elastomers-Tension

ASTM D575: Rubber Properties in Compression

ASTM D648: Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position (HDT)

ASTM D1525: Vicat Softening Temperature of Plastics (VST)

Continued on page 2

QUALITY, CONTD.

Continued from page 1

ASTM D6110: Charpy Impact Resistance of Notched Specimens of Plastics

ISO 75: Determination of Temperature of Deflection Under Load (HDT)

ISO 179-1: Plastics-Charpy Impact Properties: Non-Instrumented

ISO 180: Plastics: Izod Impact Strength

ISO 306: Plastics-Determination of Vicat Softening Temperature (VST)

ISO 604: Plastics-Determination of Compressive Properties

ISO 6603-2: Multiaxial Impact Behavior of Rigid Plastics-Instrumented Impact Test

ISO 6721-7: Plastics-Determination of Dynamic Mechanical Properties

ISO 11357-2: Plastics-Differential Scanning Calorimetry (DSC)-Determination of Glass Transition Temperature

ISO 11357-3: Plastics-Differential Scanning Calorimetry (DSC)-Determination of Temperature and Enthalpy of Melting and Crystallization

For the latest Scope of Accreditation, see:

www.datapointlabs.com/qualitysystem.asp

-Craig Montoya, Quality Manager

EVENTS CALENDAR

Upcoming events

POLYFLOW Users' Group Meeting, Court-St-Etienne, Belgium, Oct. 1,2, 2002

Materialica, Munich,Germany, Sep. 30th-Oct. 2nd, 200

CAD-FEM Users' Meeting, Friedrichshafen, Germany, Oct. 9-11, 2002

ISO TC 61, Quebec City, Canada, Nov. 13, 14, 2002

PERSONNEL

New Support Engineer joins team

DatapointLabs would like to introduce our new Team member, Support Engineer, Brian Croop. Brian holds a degree in Mechanical Engineering Technology (Penn State, Erie). Brian will be utilizing his engineering and CAE skills to fully understand and support the needs of DatapointLabs' clients.

TAP EXPANSION

New *TestPaks*™ for Polyflow, Dytran

New *TestPaks*™ have been added to meet the complete material model needs of blowmolding and thermoforming simulations using Polyflow (see article below):

Polyflow Thermoforming (Isothermal)

Polyflow Thermoforming (Non-Isothermal)

Polyflow Blowmolding (Isothermal)

Polyflow Blowmolding (Non-Isothermal)

DatapointLabs is proud to announce the addition of MSC.DYTRAN to the list of programs supported by its *TestPaks*™ Alliance Program. The following new *TestPaks*™ are available to meet the material modeling needs of MSC.Dytran users:

MSC.Dytran Isotropic Elastic (DMATEL)

MSC.Dytran Piecewise Linear Plasticity (DYMAT24)

MSC.Dytran High Speed Piecewise Linear Plasticity (DYMAT24)

Please visit www.datapointlabs.com/PartnerPrograms.asp to view additional *TestPaks*™, or call toll free (US) for details:

1-888-data-4-cae

(1-888-328-2422)

PROCESS SIMULATION

Viscoelastic models for blowmolding and thermoforming simulations

In thermoforming applications, the polymer sheet acquires its final shape after having undergone deformations. These deformations are essentially dominated by elongation components. However, contrary to continuous processes such as fibre spinning or film casting, the extensions occurring in thermoforming remain usually moderate. Typically, one may encounter Cauchy strains of the order of 5, and the corresponding Hencky strains are thus of the order of 1 or 2. Consequently, the knowledge of the linear response is usually sufficient, since the deformations involved are such that the expected polymer response essentially remains within the scope of the linear viscoelastic properties.

Indeed, if one considers typical transient elongational viscosity curves for several polymers, one finds that they follow the linear response up to a Hencky strain of about 2, whatever the strain rate. The deviation with respect to this quasi-linear behavior starts beyond a Hencky strain of about 2, thus when the shaping process is already achieved.

Furthermore, one usually observes a strikingly similar behavior of the transient elongational viscosity at increasing strain rates. In particular the deviation with respect to the linear behavior is found beyond a Hencky strain of 2. This permits an estimate of the elongational behavior at strain rates that are not achievable in measurements, and that are typical in the industrial practice.

From the point of view of the modelling, multimode viscoelastic models exhibit the same early development of the transient elongational viscosity. This is a consequence of the linear properties, which are fully described by means of the oscillatory measurement (G' and G"). This is an interesting feature, since the use of a quasi-linear viscoelastic model with a relaxation spectrum identified on the basis of linear properties is sufficient for performing a simulation of a broad range of thermoforming applications.

Author's Note:

Definition of Cauchy and Hencky strains.

Let us consider a material element of initial length L_o, and stretched up to a length L. The Cauchy strain e^C is defined as the ratio of the current length L to the initial one:

$$\varepsilon^C = \frac{L}{L_0}$$

The Hencky strain e^H is defined as the sum of all infinitesimal strains from the initial length L_0 to the deformed state of length L:

$$\varepsilon^H = \int_{L_0}^{L} \frac{dl}{l} = ln\, \frac{L}{L_0} = ln\, \varepsilon^C$$

References:

C.W. Macosko, Rheology, principles, measurements, applications. Wiley-VCH (1994)
A.S. Lodge, Trans Faraday Soc., 52 (1956) 120-180.

-Benoît Debbaut, Polyflow s.a./Fluent Benelux

COUPLED FEA ANALYSIS

Simulating hydroplaning using MSC.DYTRAN

Predicting tire tread patterns that minimize the effects of hydroplaning is a critical safety issue for tire manufacturers. Hydroplaning occurs when a vehicle reaches a certain velocity on a wet road and the tire lifts off the road, minimizing contact and friction with the road surface.

MSC.Dytran was utilized to simulate hydroplaning velocity, including interaction between tire tread design, deformation and surrounding fluids, because of its superior analysis of coupled problems between fluids and structures. Using finite element method (FEM) to solve structural deformation and finite volume method (FVM) to solve fluid behavior, MSC.Dytran can accurately predict the tire performance running on a wet road by coupling the two methods. For this simulation, the tire structure is modeled by Lagrangian formulation (FEM) and the fluid is modeled by Eulerian formulation (FVM).

Hydroplaning can best be explained with the three-zone concept shown in Figure 1. When a vehicle drives at low speed, Region C dominates the contact patch. As velocity increases, Region A becomes dominant and when the tire is completely lifted, region C diminishes. This simulation targets Region A, analyzing the dynamic pressure caused by the collision of water film and the front edge of the tire. When the tire begins lifting off the road, hydroplaning velocity has been achieved.

Tires are composite material structures made up of many different components, including carcass, belts, cap tread, side tread, and bead core. The carcass and belt have high elastic modulus and thin composite materials, so they are modeled using multi-layered shell elements. This reduces the number of iterations that would have been computed had continuum elements been used. Likewise, the bead core has a very high elastic modulus and is modeled as rigid elements, reducing the number of iterations computed. All of the other tire components are modeled with 8-node continuum elements.

The geometrically complex tire tread pattern is modeled using finite elements. Then the tire body is modeled separately. The two models are combined with a rigid connection (Figure 2). This eliminates coinciding nodes at the interface surface between tire and tread pattern, enabling the FE modeling of tread patterns with complex and arbitrary shapes.

The water layer is modeled using 8-node continuum elements. The bottom surface of the water layer coincides with the road surface that was modeled as a rigid body, and the water layer is defined on the upper side of the road surface with a thickness of 10 mm. On top of the water layer, a vacant space called void is defined to enable water scattering. By defining the Eulerian elements initially, where water is expected to move, free surface of water can be simulated and enables the analysis of water scattering drained by tread patterns. Element size of water layer needs to be less than or equal to the tire groove width. However, if finer meshes are adapted to the entire region of water layer, the computation time becomes impractical. To obtain sufficient accuracy and to reduce processing time, water layer around contact area where deformed tire and fluid interfere is equally divided into small size meshes. In the other region away from the contact region, the sizes of the mesh are increased according to the geometric ratio as shown in Figure 3. (Water is assumed to be incompressible and also a laminar flow).

The General Coupling algorithm of MSC.Dytran was utilized because it enables tire deformations to couple with surrounding fluid by overlapping on the fluid elements. This allows modeling of the hydroplaning phenomena in which surrounding fluid is drained by the complex tread pattern of the tire.

In order to reduce the number of elements to a manageable number, a moving reference frame fixed on the traveling vehicle is used. Instead of the tire moving on the fixed road, the transverse velocity is applied to the road and the tire rotates at the fixed position. Simultaneously, inertial force is applied to the fluid so that the same velocity as the road surface is generated. This simulates a reduction in the contact force between tire and road as flow velocity increases and dynamic pressure of the water lifts the tire incrementally. The relationships between fluid velocity and contact force determine hydroplaning velocity.

To verify the effectiveness of simulation for predicting hydroplaning velocity, four different tread patterns, including smooth, 9mm wide longitudinal groove 18mm wide longitudinal groove and a V-shape groove were modeled and compared with physical tests. Specifications of the tires are 195/65R15, vertical load 4kN and inflation pressure 200kPa.

The predicted hydroplaning velocities for the four tread patterns were compared to experiments with physical tires. The simulation results were confirmed. Additionally, simulated water flows around contact patch area agreed with the video of the experiment. As a result, the new procedure enables a prediction of the hydroplaning process and differences in performance based on the tread pattern of the tire.

-Casey Heydari, MSC.Software

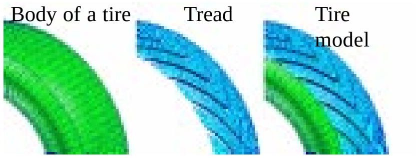


Figure 2. Tire and thread pattern

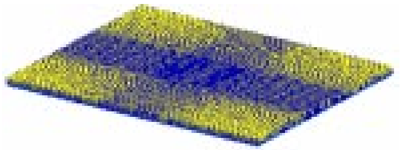


Figure 3. Finite volume model for water

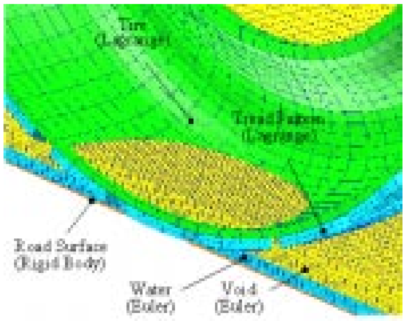
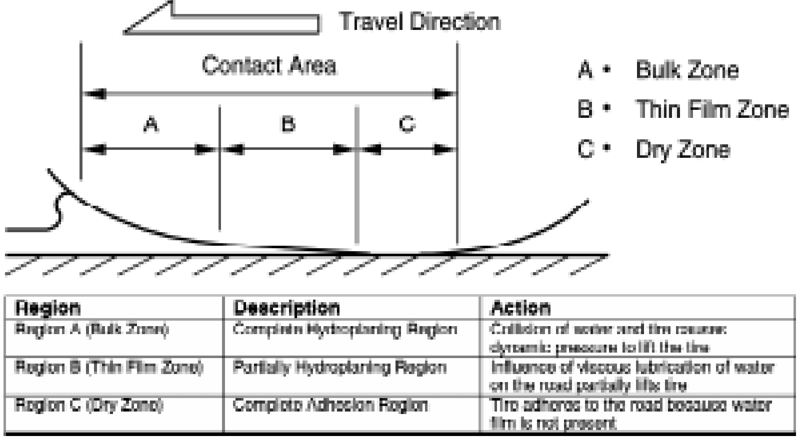


Figure 4. Models of tire and water film



Region	Description	Action
Region A (Bulk Zone)	Complete Hydroplaning Region	Collision of water and tire causes dynamic pressure to lift the tire
Region B (Thin Film Zone)	Partially Hydroplaning Region	Influence of viscous lubrication of water on the road partially lifts tire
Region C (Dry Zone)	Complete Adhesion Region	Tire adheres to the road because water film is not present

Figure 1. Three zone concept