

ICAR PLUS

Concrete Rheometer



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Who we are ?



For almost half a century, **Germann Instruments** has been one of the leaders in the field of systems for nondestructive testing (NDT) and on-site investigation of reinforced concrete structures.

We constantly develop, manufacture and market worldwide our innovative and cutting-edge product line of test systems that cover varied aspects of concrete construction and investigation, such as:

In-Place Strength

Rheology

Defect Detection

Corrosion Evaluation

Service Life Estimation

Repair Quality

Concrete Mixture Optimization

Condition Assessment

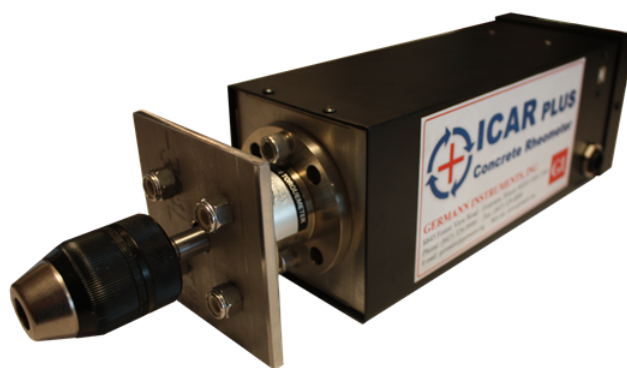
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Fundamentals

- ❖ **Concrete** is a granular material with various fresh and hardened properties depending on the mixture proportions. Aside from the obvious importance of hardened concrete properties in terms of strength, durability, etc., fresh properties are very important in terms of the final result of different casting applications. For any given casting application, **fresh concrete** must flow in a certain way to fill the mold, encapsulate all reinforcements and other embedments, and create a dense structure.
- ❖ **The fresh concrete's resistance to flow** is important since it determines how easy or difficult the casting operation will be. **The performance of fresh concrete** can be described using two different properties: its resistance to flow and its behavior when it is flowing. Both these properties influence the casting procedure and its result.
- ❖ **There are various procedures** to characterize fresh properties of concrete: empirical methods and scientific methods. However recently **scientific methods such as rheology tests** are widely used because empirical methods do not provide enough information about the flow behavior of fresh concrete.
- ❖ **Rheology** is the science of the flow and deformation of matter (liquid or “soft” solid) under the effect of an applied force. The basic principle behind rheological measurements is to **deform the material** in a controlled way and simultaneously record the material's resistance to such a deformation.
- ❖ **The instruments** used for rheological measurements are known as rheometers. With this purpose, **Germann Instruments** proudly presents the **ICAR Plus rheometer** which is simple, portable, and able to capture both of the key parameters characterizing fresh concrete: resistance to flow, and how it flows once this resistance is overcome.



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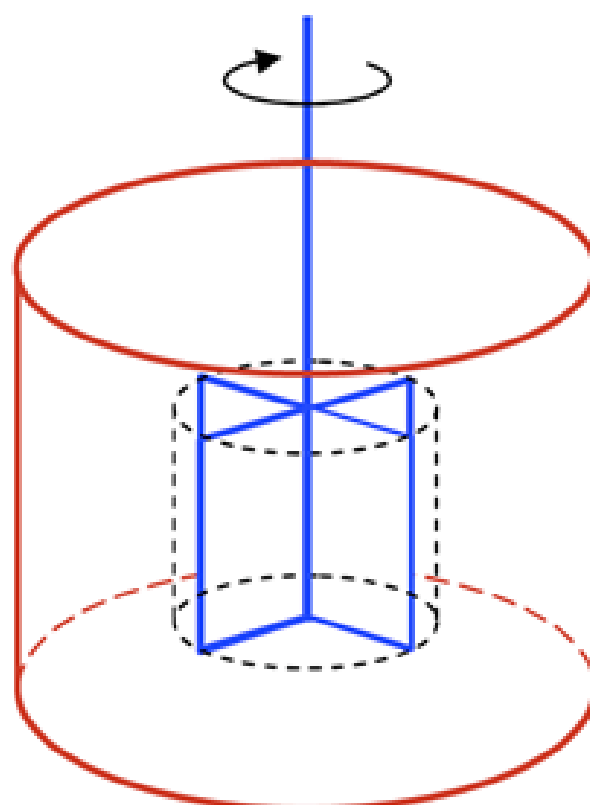
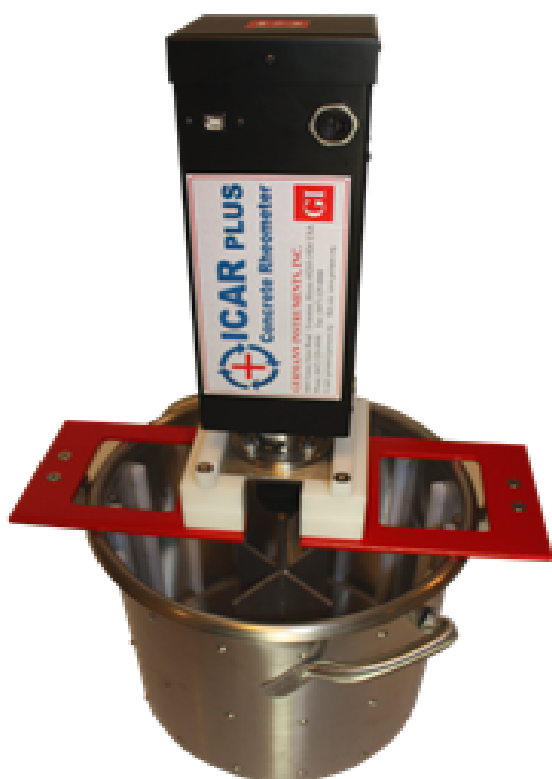
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ICAR Plus Principals

The **ICAR Plus rheometer** consists of a **container** as an outer cylinder and a **four-bladed vane** as an inner cylinder. Why a **vane**?

- **Avoiding** the slippage between the rotating inner cylinder surface and the fresh concrete.
- **The action of inserting the vane** into the specimen creates minimal disruption to the specimen, which is particularly important for thixotropic materials where shear history influences results.
- Making the whole system **light**, and thus **portable**.



To perform a test, the **ICAR Plus rheometer** needs to connect to the computer by USB cable and then run the **ICAR Plus software**.

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ICAR Plus Software

The screenshot shows the ICAR Rheometer software interface. At the top, there are tabs for 'File Setup', 'Geometry', and 'Defaults'. The 'File Setup' tab is active, showing fields for 'File Name Prefix', 'Output Directory', and checkboxes for 'Include date' and 'Generate raw data file'. A 'Verify calibration' window is open, with a green calibration light and a 'Reset' button circled in red. The 'GERMANN INSTRUMENTS, INC. GI' logo is in the top right corner.

The main interface is divided into two sections: 'Stress Growth Test' and 'Flow Curve Test'. The 'Stress Growth Test' section has a 'Test Speed (rps)' input field set to 0.050, circled in red. Below it is a plot area with the text 'Enter speed for stress growth test'. The 'Flow Curve Test' section has a table of parameters circled in red:

Breakdown Time (s)	Breakdown Speed (rps)	Number of Points	Time per Point (s)	Initial Speed (rps)	Final Speed (rps)
5.0	0.500	7	5.0	0.500	0.050

Below the table are radio buttons for 'Torque vs Time' (selected) and 'Torque vs Speed'. A 'Start' button is also present. The plot area for the flow curve test has the text 'Enter parameters for flow curve test' and 'Flow curve test results'. At the bottom, there are sections for 'Test Results' (Peak Torque and Yield Stress) and 'Relative Parameters' (Y, V, R²) and 'Bingham Parameters' (To, μ, mse), all circled in red.

At the bottom of the window, the status bar shows: 'ICAR Rheometer: DAZ5SAZT | 00.80 | Calibrating | No Communication | 3.0.0.78'.

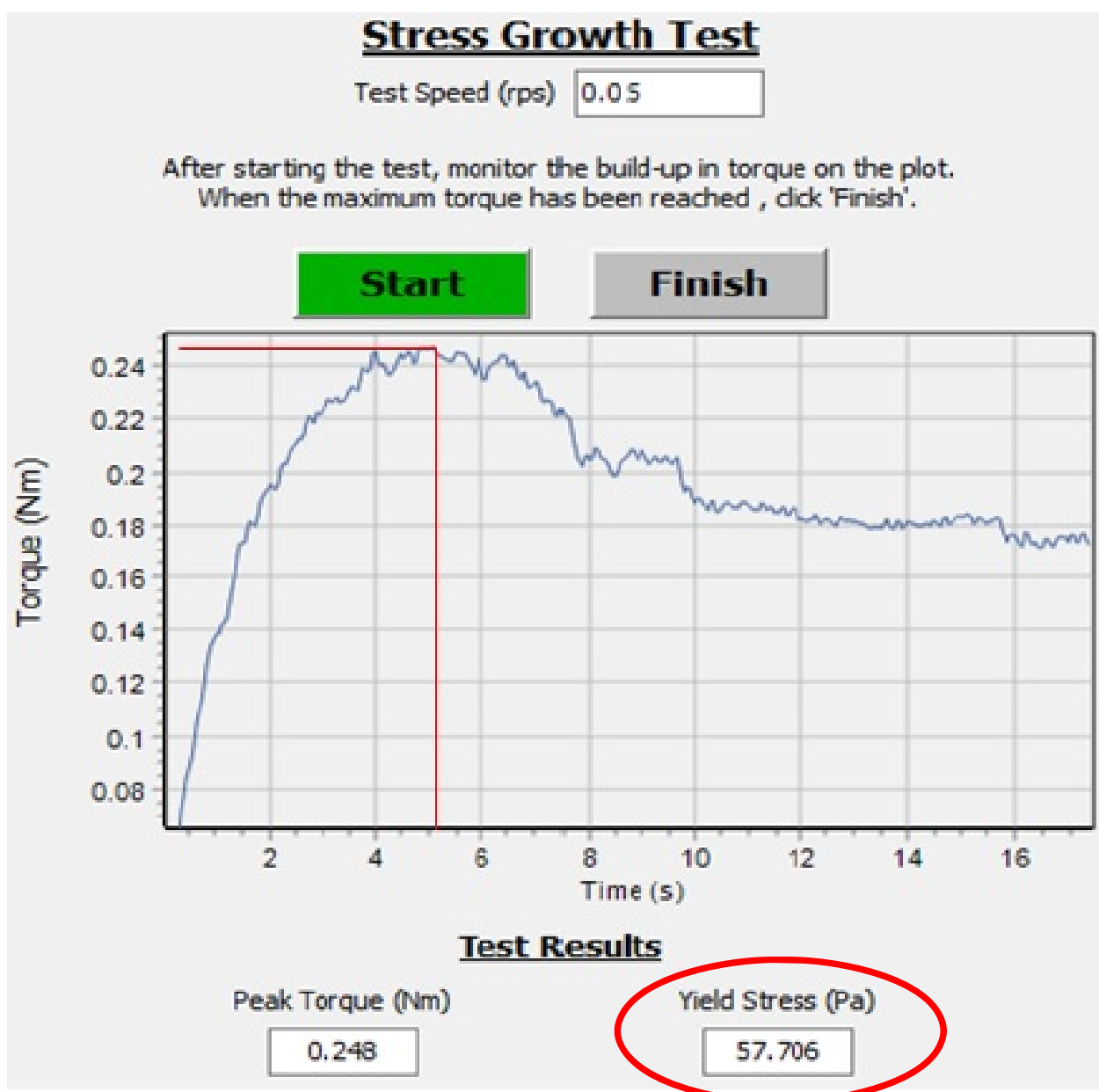
The **ICAR Plus software** operates the rheometer, records test data, computes test results, and stores data. There are two measurements performed by the software: **Stress Growth Test** and **Flow Curve Test**.



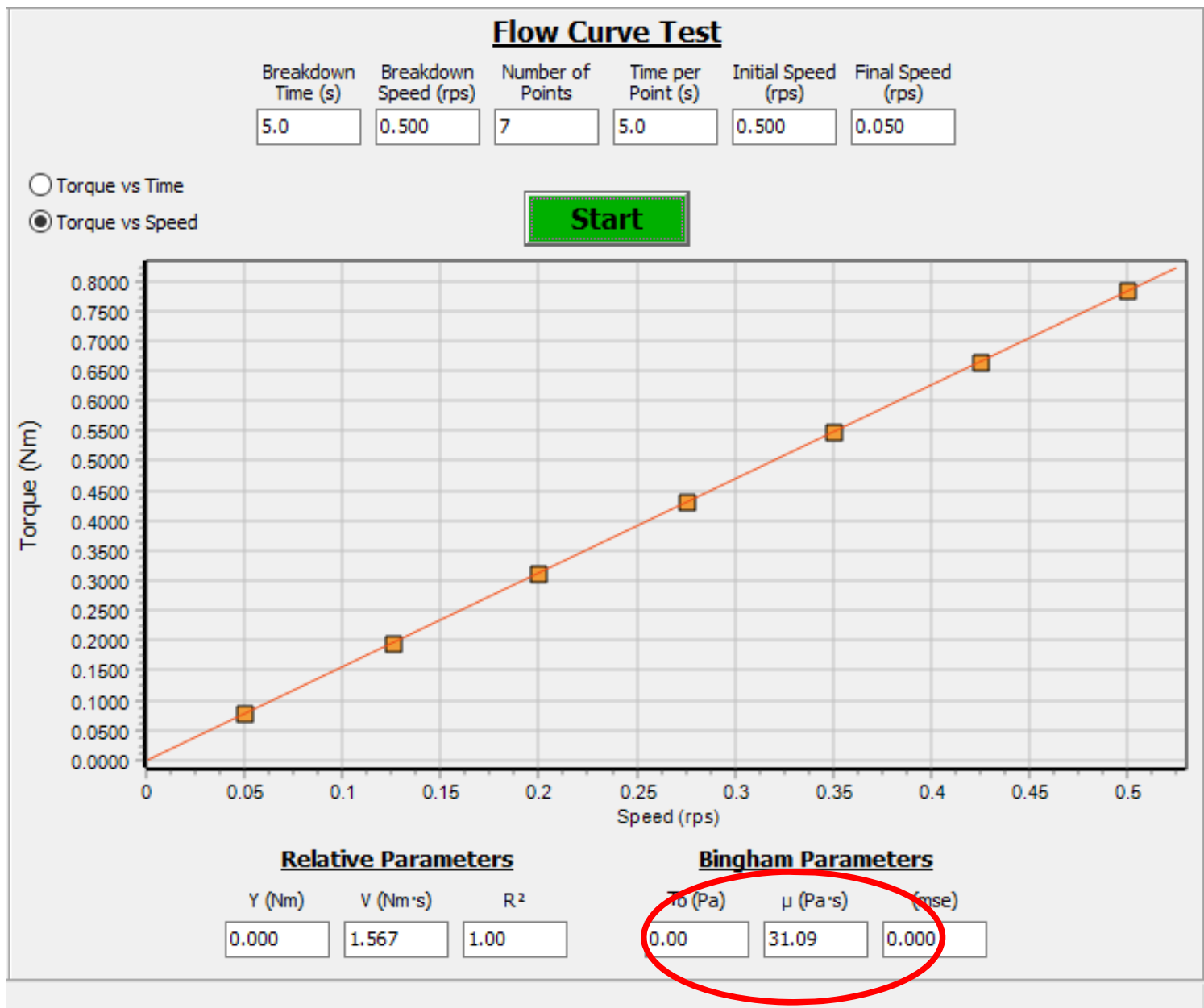
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ICAR Plus Measurements

The **Stress Growth Test** involves rotating the vane to shear the concrete very slowly at a constant rotational speed and measures the torque. The maximum torque corresponds to the **static yield stress**, representing the stress needed to be overcome in order to initiate flow from a state of rest.



ICAR Plus Measurements



The **Flow Curve Test** measures the relationship between **shear stress** and **shear rate** and computes the **Bingham parameters** of yield stress T_0 (Pa) and plastic viscosity μ_{pl} (Pa.s). The yield stress here is the **dynamic yield stress**, which is obtained when the rate of deformation slows down from high to low values, thus it is the stress needed to maintain the flow.

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Workability for Self-Compacting Concrete



Box shows acceptable combinations of
plastic viscosity and dynamic yield stress

(Eric Kohler)

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ICAR Plus Key Features

❖ APPLICATIONS:

- ✓ Research and Development
- ✓ Mixture Optimization
- ✓ On-Site Quality Control



❖ BENEFITS:

- ✓ Portable (Laboratory, Job-Site)
- ✓ Appropriate for Moderately and Highly Flowable Concretes
- ✓ Practical for Field Use (only 1 Minute for Testing)
- ✓ Flexibility Data Management
- ✓ Affordable Investment

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ICAR Plus Specifications



- **Minimum slump.** The concrete has to have a slump greater than 75 mm, otherwise the concrete is too stiff for testing by the apparatus
- **Nominal maximum size of aggregate:** 32 mm for largest available container
- **Vane rotation speed:** 0.001 to 0.667 rev/s
- **Motor type:** Integrated Servo Motor
- **Minimum Torque:** 0.01 Nm
- **Peak Torque:** 90 Nm for not more than 2 seconds
- **Continuous Maximum Torque:** 32 Nm
- **Power Supply:** Input of 100-240 VAC – 3.5 A. Output of 48V - 6.7A. IP67
- **Test time:** 1 minute
- **Computer requirements:** Windows 7 or higher. Processor I3 or higher.
- **Motor drive dimensions:** 11 x 11 x 43 cm
- **Motor console weigh:** 7.5 kg
- **Carrying Case dimensions:** 67 x 52 x 28 cm
- **Carrying Case weight:** 20 kg, Including Motor Drive, Base Frame, Vane, Power Supply and Cables

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ICAR Plus Parts Number



- ❖ Motor drive/torque meter unit: **RHM-5001**
- ❖ Power cord for motor drive/torque meter unit: **RHM-5002**
- ❖ Base plate for attaching motor drive/torque meter unit to container: **RHM-3003**
- ❖ Container for 19 mm NMSA aggregate – standard: **RHM-3005**
- ❖ Four-blade vane for 19 mm NMSA aggregate: **RHM-3009**
- ❖ USB cable to connect motor drive/torque meter unit to computer: **RHM-3012**
- ❖ Laptop computer with installed software: **RHM-5013**
- ❖ Software on CD-ROM: **RHM-5014**
- ❖ User manual: **RHM-5015**
- ❖ Carrying case for laptop computer: **RHM-5016**
- ❖ Carrying case for Rheometer and accessories: **RHM-5017**
- ❖ Silicone oil for verification of instrument (19 L): **RHM-5018**

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