




American Concrete Institute®
Advancing concrete knowledge

Quality Control and Robustness of SCC, Part 2

ACI Spring 2012 Convention
March 18 – 21, Dallas, TX


Denis Beaupre, Managing Director, IBB
Rheology, Quebec, QC, Canada



IBB Probe


IBB PROBE & SYSTEM

By Dr. Denis Beaupre



IBB Probe - Contents

- IBB & Vision
- Rheology of Concrete
- What is the IBB Probe
- Measurements
- Precision
- Performance



IBB Probe - Vision

IBB Vision is:

“by 2020, all new ready-mix trucks will have a IBB Rheological probe as a standard equipment”



IBB Probe

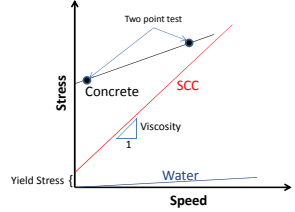


Display

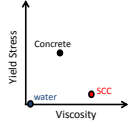


IBB Probe – Rheology


- Rheology is the science of flow
- For fresh concrete, it measures Yield Stress (somewhat related to the slump) and the Viscosity



Stress vs Speed graph showing concrete and SCC curves. A two-point test is indicated. A triangle labeled 'Viscosity' is shown with a slope of 1. The x-axis is labeled 'Speed' and 'Water', and the y-axis is labeled 'Yield Stress'.



Yield Stress vs Viscosity graph showing concrete and SCC points. A red arrow labeled '(Probe)' points from the Stress vs Speed graph to this one.



IBB Probe – Rheology

- Change in composition will affect the rheological properties
- Since no rheometer uses same dimension/principle, no agreement has been found on fundamental units
- IBB Units:
 - Yield Stress = kPa
 - Viscosity = kPa/s

IBB Rheology

IBB Probe – Rheology

- For each application, there is a workability box that can be drawn
- The viscosity is an important parameter for special concrete

IBB Rheology

IBB Probe - What is the IBB Probe

- The IBB Probe is a sensor that allow to assess some concrete properties (Slump, Temperature) inside the drum of a ready-mix truck, automatically, without sampling and on a continuous basis
- Properly used, it also give rheological properties

IBB Rheology

IBB Probe – Basic System

IBB Rheology

IBB Probe – Measurements

- Angle, Speed and direction of the drum
- Load on probe when in concrete displayed as a Pressure (kPa)
- Rheological properties: Yield and Viscosity (kPa, kPa/s)
- Voltage of the probe's batteries (V)
- Concrete Slump estimation (mm or inches)
- Temperature of the concrete (C or F)
- Volume estimation (V3 or m3)
- Probe is fully calibrated for speed, load, pressure, temperature and slump at the factory

IBB Rheology

IBB Probe – Display

Speed	15	Slump	125
Pressure	72	Temp	24.6
Yield	31	Volume	8.5
Viscosity	55		
Voltage	62		

IBB Rheology

IBB Probe – Basic System

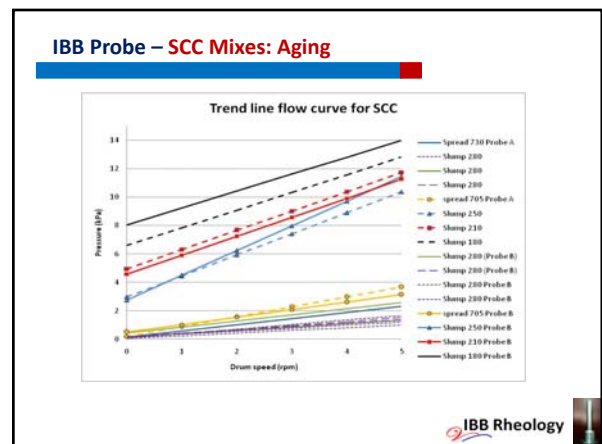
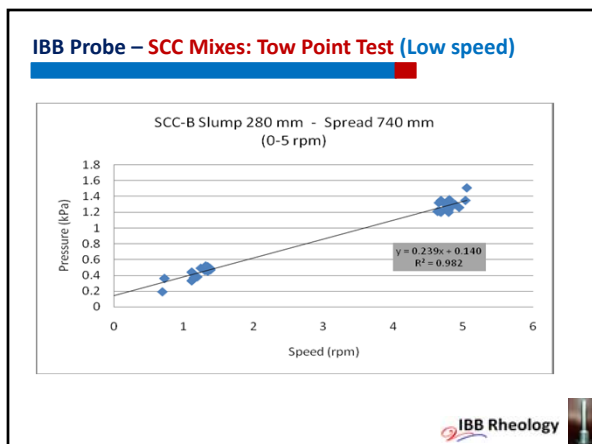
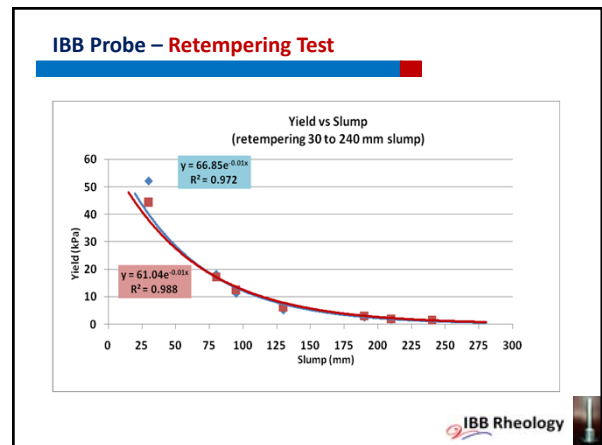
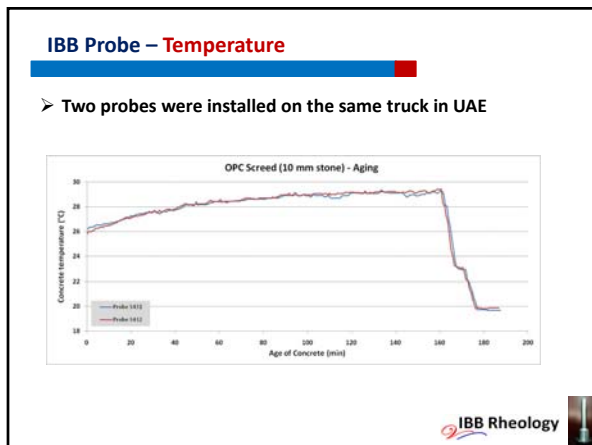
- System goes to sleep when speed too low
- Probe detects when it is concrete
- Measures temperature
- Measures load and speed for two speed values
- Calculates Viscosity and Yield
- Estimates slump from Yield
- Calculates volume inside the drum
- Sends data to Display by radio every turn or 10 seconds

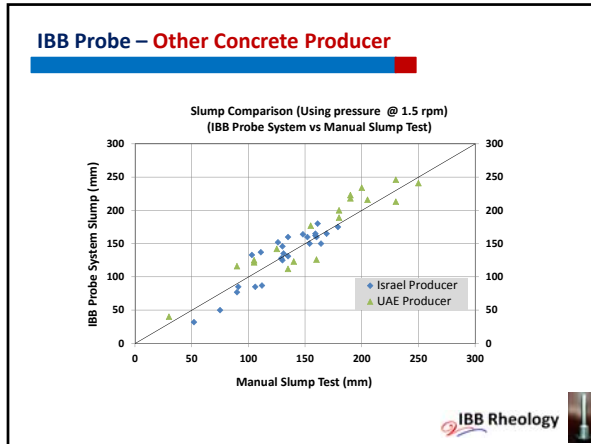
IBB Rheology

IBB Probe – System Manager (in development)

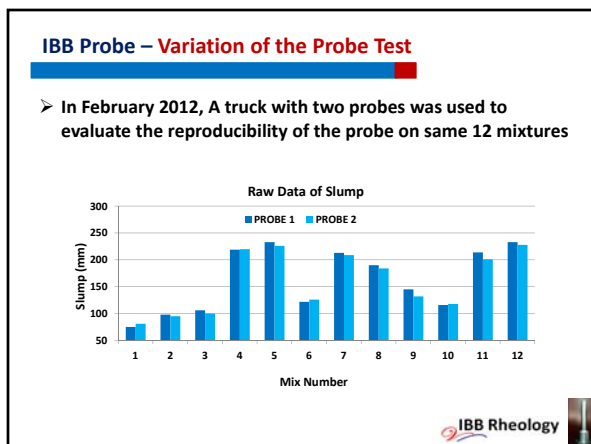
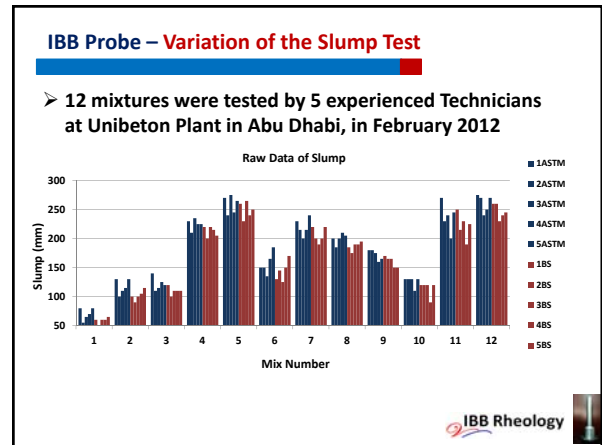
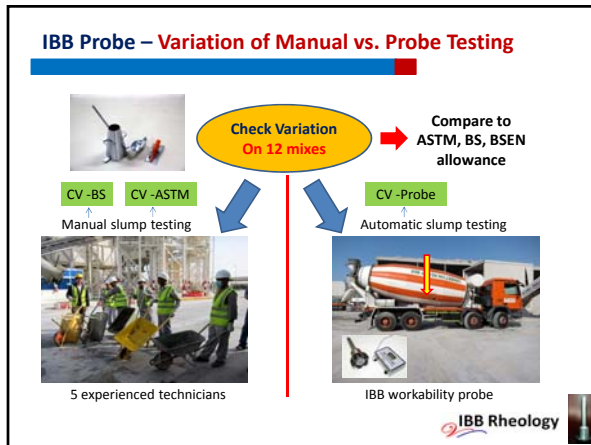
- A System Manager can be installed at the batching plant
- It allows two ways communication between the Probe, the Display and the Plant Operator.

IBB Rheology





- ### IBB Probe – Precision of Manual vs. Probe Testing
- The relationship between the manual slump and the IBB Slump depends on:
 - Precision of the slump test itself
 - Precision of the probe itself
 - Calibration between the probe and the slump test
 - Operational mode of both tests
 - Best way to look at precision is to calculate the coefficient of variation (CV)
- IBB Rheology



IBB Probe – Variation of the Probe Test

MIXTURE	1	2	3	4	5	6	7	8	9	10	11	12
Average ASTM	70	117	122	225	259	157	220	200	172	126	237	261
Standard Dev ASTM	10.6	13.0	11.5	9.4	15.6	18.9	15.4	9.4	9.1	8.9	25.4	15.2
CV ASTM	15.2	11.1	9.4	4.2	6.0	12.0	7.0	4.7	5.3	7.1	10.7	5.8
Average BS	59	102	110	212	249	144	206	187	160	114	222	247
Standard Dev BS	5.5	9.1	7.1	9.1	14.3	17.8	13.4	7.6	9.4	13.4	22.0	13.0
CV BS	9.3	8.9	6.4	4.3	5.8	12.4	6.5	4.1	5.8	11.8	9.9	5.3
Average Probe	64.5	109.5	116	218.5	254	150.5	213	193.5	166	120	229.5	254
Standard Dev Probe	4.2	2.1	4.2	0.7	4.9	2.8	2.8	4.2	9.2	1.4	9.2	3.5
CV Probe	5.4	2.2	4.1	0.3	2.2	2.3	1.3	2.3	6.6	1.2	4.4	1.5

IBB Rheology

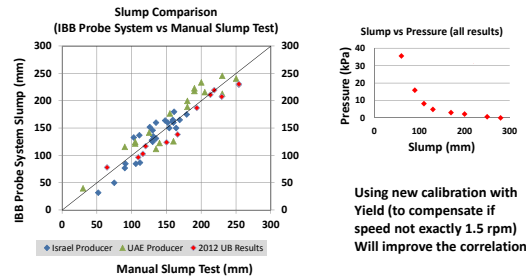
IBB Probe – Data from Display Log (Sequence from Feb 2012 test at UB)

2012-02-06T12:55:50	POS=-78.63	TEMP=30.68	SRPM=0.95	pres=2.70	slump=188.89	VBAT=6.5	volume=0.31
2012-02-06T12:56:35	POS=-78.63	TEMP=30.68	SRPM=0.88	pres=2.70	slump=188.89	VBAT=6.6	volume=0.31
2012-02-06T12:57:20	POS=-78.59	TEMP=30.68	SRPM=0.92	pres=2.71	slump=184.37	VBAT=6.6	volume=0.30
2012-02-06T12:58:05	POS=-78.59	TEMP=30.68	SRPM=0.87	pres=2.71	slump=184.37	VBAT=6.6	volume=0.30
2012-02-06T12:58:50	POS=-78.59	TEMP=30.68	SRPM=0.84	pres=2.71	slump=184.37	VBAT=6.6	volume=0.30
2012-02-06T12:59:35	POS=-78.60	TEMP=30.78	SRPM=0.88	pres=2.73	slump=182.15	VBAT=6.6	volume=0.29
2012-02-06T13:00:20	POS=-78.74	TEMP=30.78	SRPM=0.93	PRES=2.71	slump=182.17	VBAT=6.5	volume=0.27
2012-02-06T13:01:06	POS=-78.74	TEMP=30.78	SRPM=0.95	pres=2.71	slump=182.17	VBAT=6.6	volume=0.27

- To evaluate the probe precision, it is best to look at the pressure variation from turn to turn with time. The calibration with the slump is independent of this.
- From turn to turn , the pressure measurement is quite constant, increasing slowly; as expected...



IBB Probe – All Data Available so far (all with initial UB Calibration)



IBB Probe – Correlation Between Slump and Probe

- Calibration is done at a given speed when using pressure
- If speed is not exactly what is has been calibrated with, it will cause some error
- The use of the yield will eliminate the need to be exactly at the calibrated speed
- The new software will use this concept



IBB Probe – Performance

- The Probe stay general clean inside the drum
- Wear measurement indicate a potential life of 30-50 thousand cubic meter



IBB Probe – Conclusions

- After 3 years of development and many versions of the IBB probe, the system is a good tool to evaluate automatically and continuously the fresh properties inside a ready-mix truck
- The system is easy to install, gives direct measurements and does not depend on the amount of concrete inside the truck
- A good thing to install on all new trucks

