



COMBINING *INTERNET-OF-THINGS* AND *CHEMISTRY*: ADMIXTURE-ON-DEMAND

N. Tregger



LET'S TENDERIZE MEAT! CHEMICAL OR MECHANICAL APPROACH?

Chemistry: acid and enzyme break down of protein



beeflovingtexans.com/



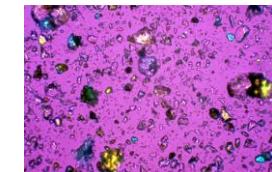
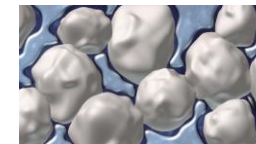
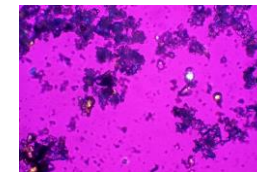
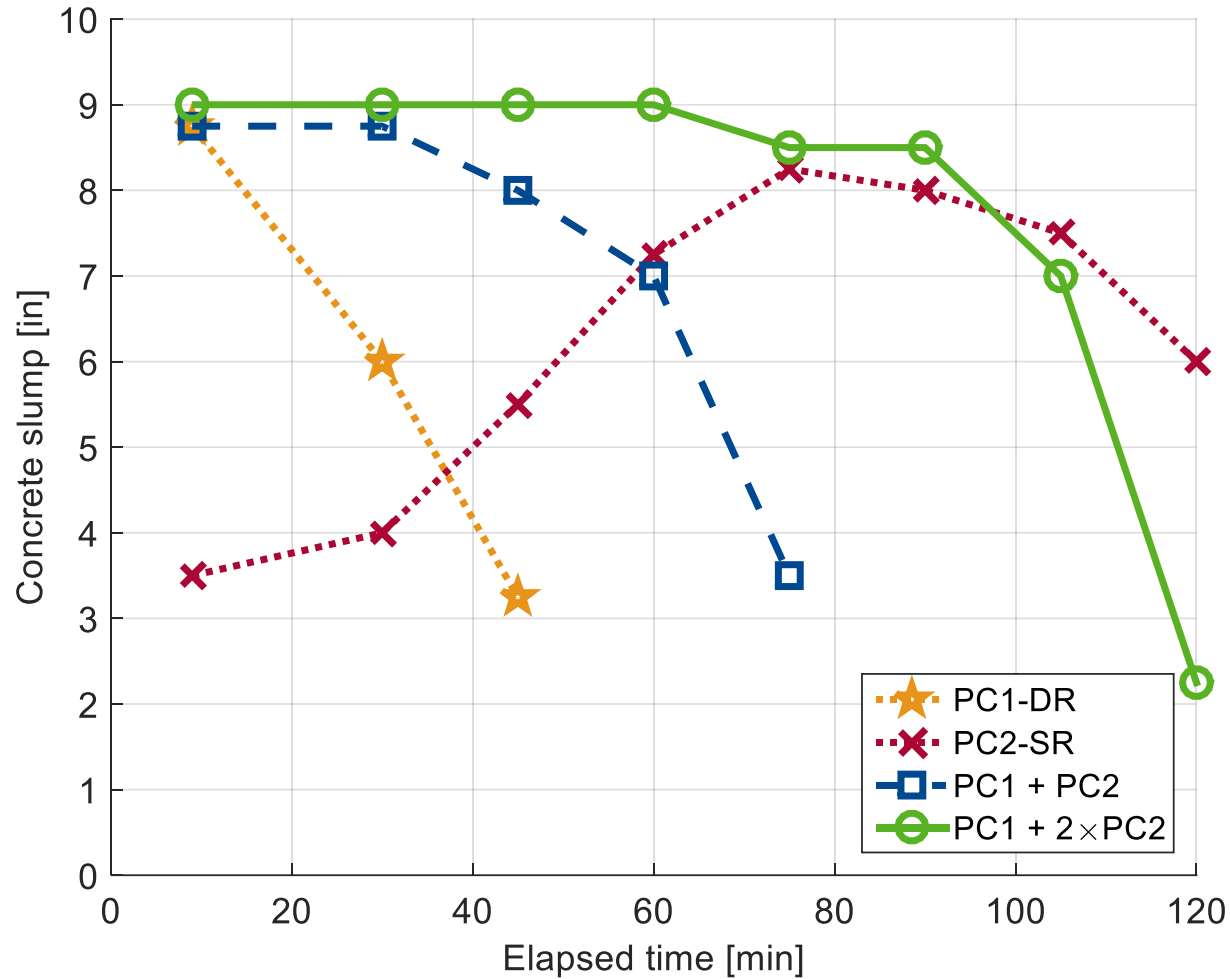
cupcakesandkalechips.com/chili-lime-cube-steaks-recipe/

Mechanical: 100% Julia Child style!



<https://www.saturdayeveningpost.com/>

CHEMICAL METHOD TO SLUMP RETENTION



Without PCE

With PCE

Polycarboxylates can be tailored and formulated to achieve slump retaining properties. Cement and aggregate characteristics can affect the overall slump retention of a given concrete mix.

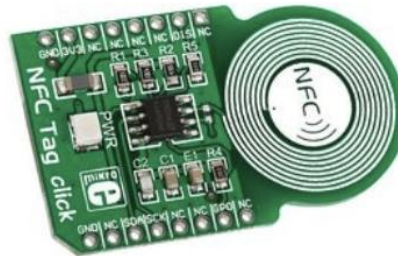
INTERNET-OF-THINGS (IOT)



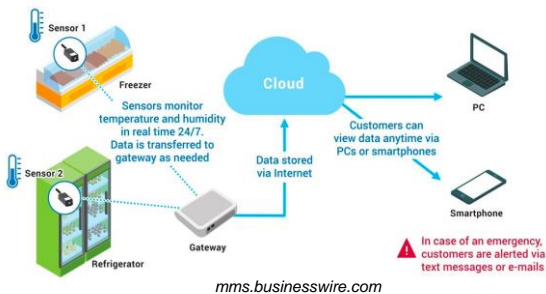
Temperature sensor ~ \$1.00
cdn.sparkfun.com



NFC sensor ~ \$0.10
users.ece.utexas.edu



GPS module ~ \$10.00
electronicwings.com



mms.businesswire.com



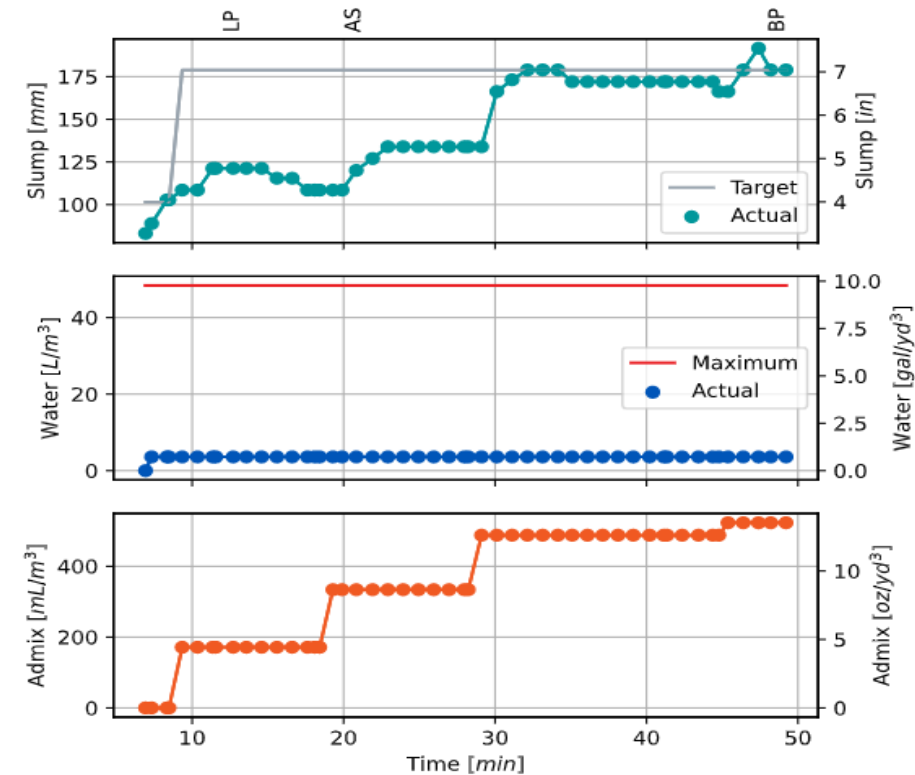
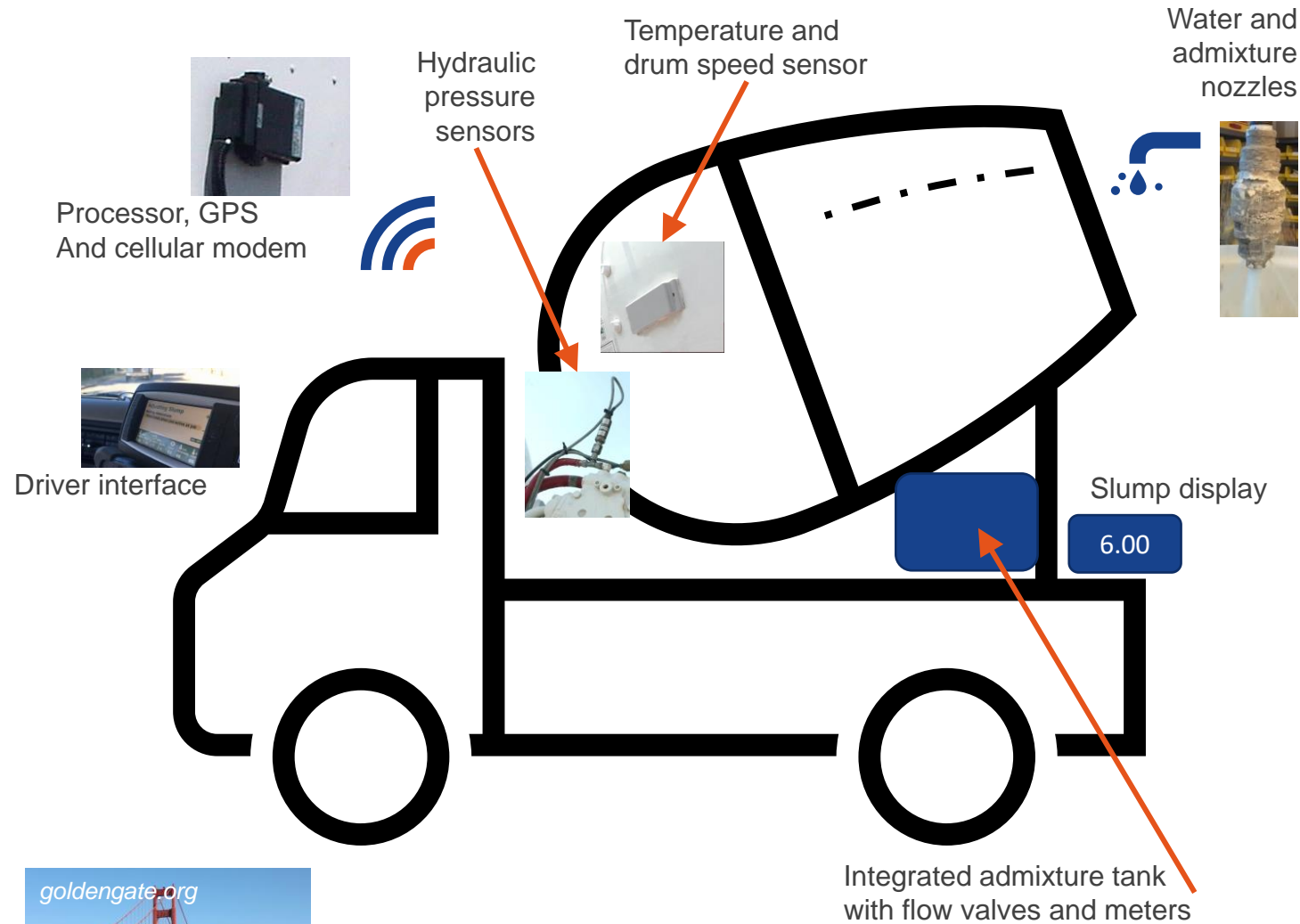
forbes.com



gineersnow.com

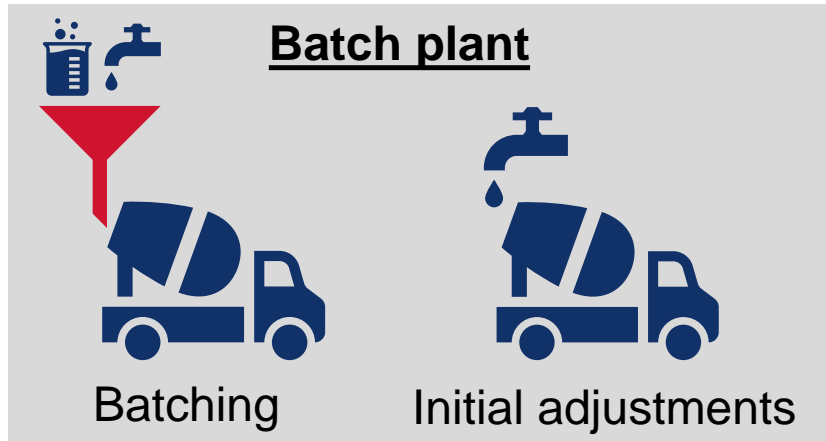
IoT relies on sensors, data and analysis

MECHANICAL FEEDBACK SYSTEMS THROUGH IOT



- 160 million cubic yards \approx 400 Golden Gate Bridges
- Over a **billion** data points

THE READY-MIX DELIVERY CYCLE



In-transit



THE READY-MIX DELIVERY CYCLE

Traditional

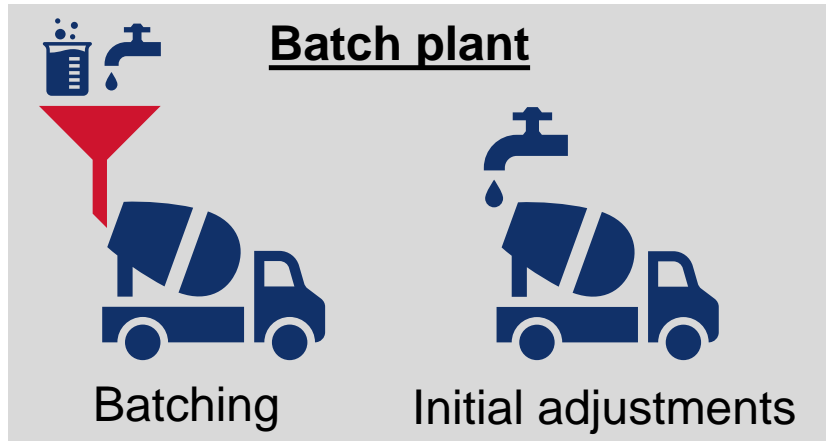
Batch person /
Trim water



Truck driver /
Slump rack water



Truck driver /
Final adjustment

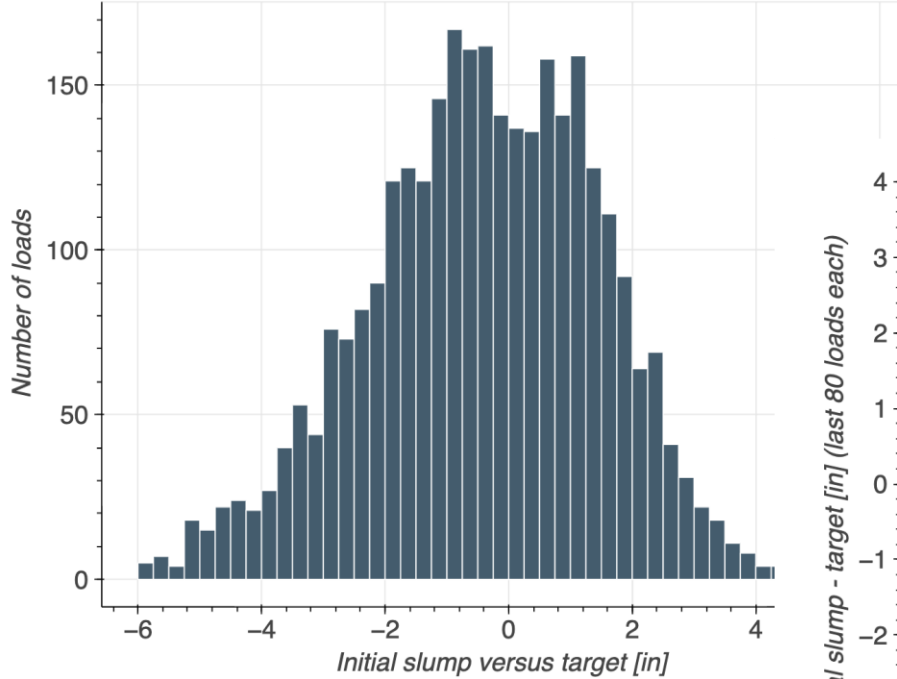


In-transit

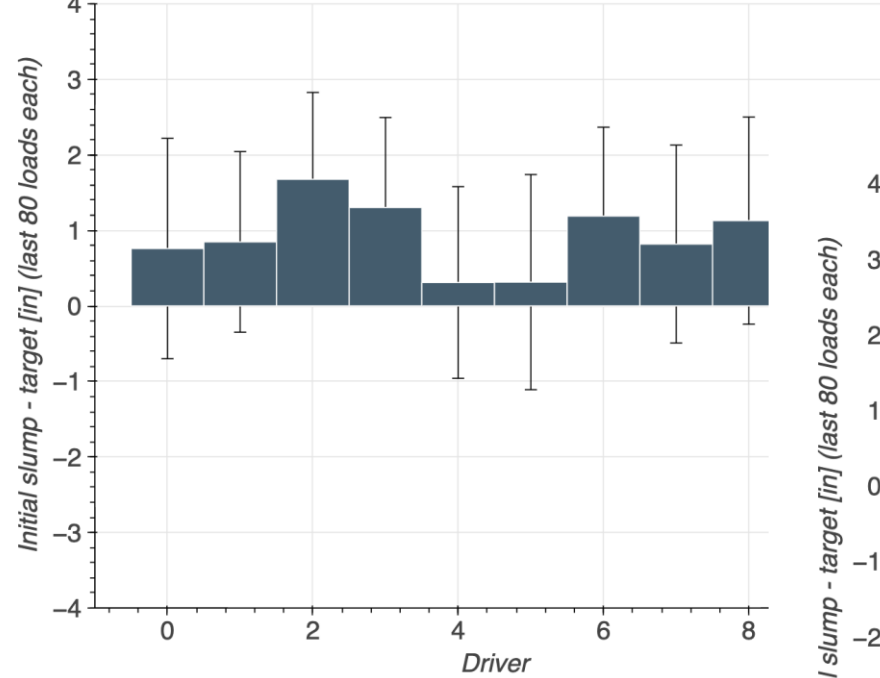


CHALLENGES AT THE PLANT

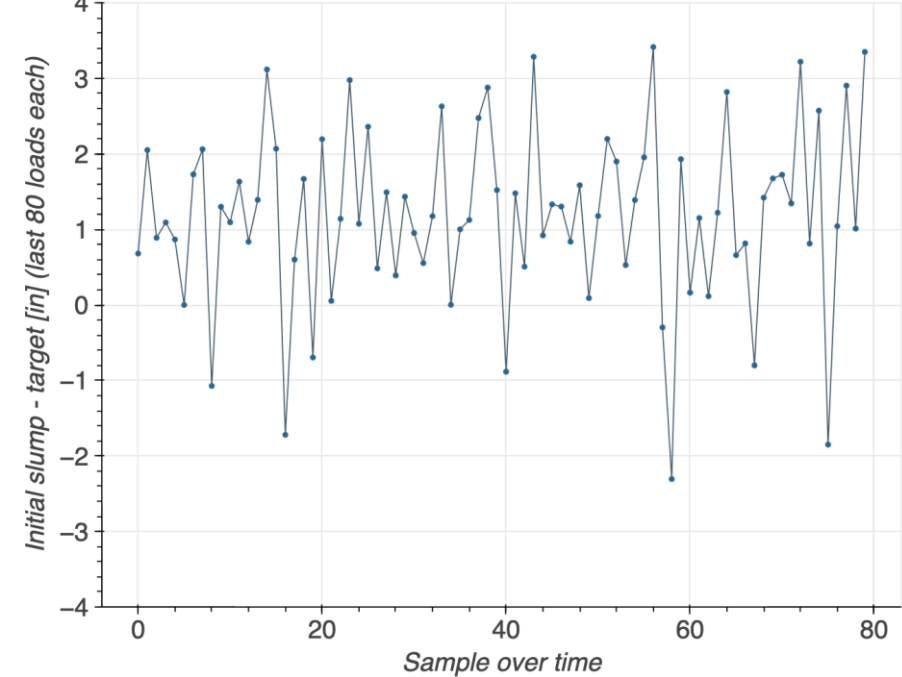
GHOST mode - 3,080 loads since 2016; AVG = -0.4 in, STD = 1.9 in



Driver mean and standard deviation based on last their 80 loads



Driver initial slump versus target over time



Batching is a team sport! Data allows RMX to make informed decisions.

THE READY-MIX DELIVERY CYCLE

Traditional

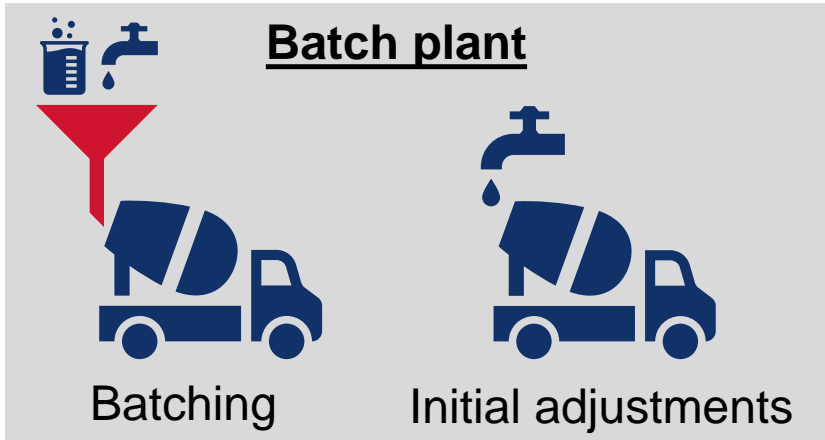
Batch person /
Trim water



Truck driver /
Slump rack water



Truck driver /
Final adjustment



IoT



Historical data /
Trim water



Feedback system /
Water/admix to **initial slump**

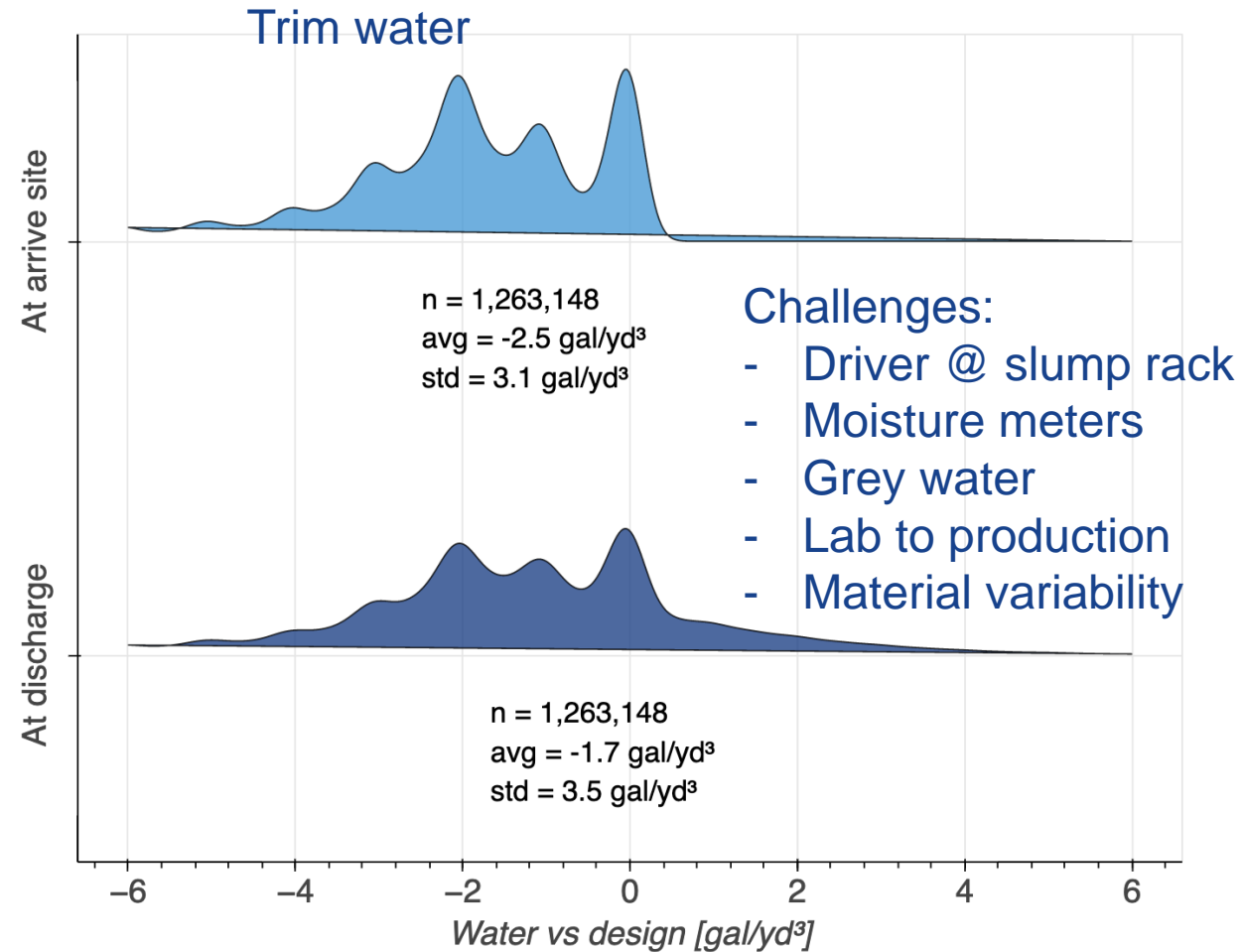
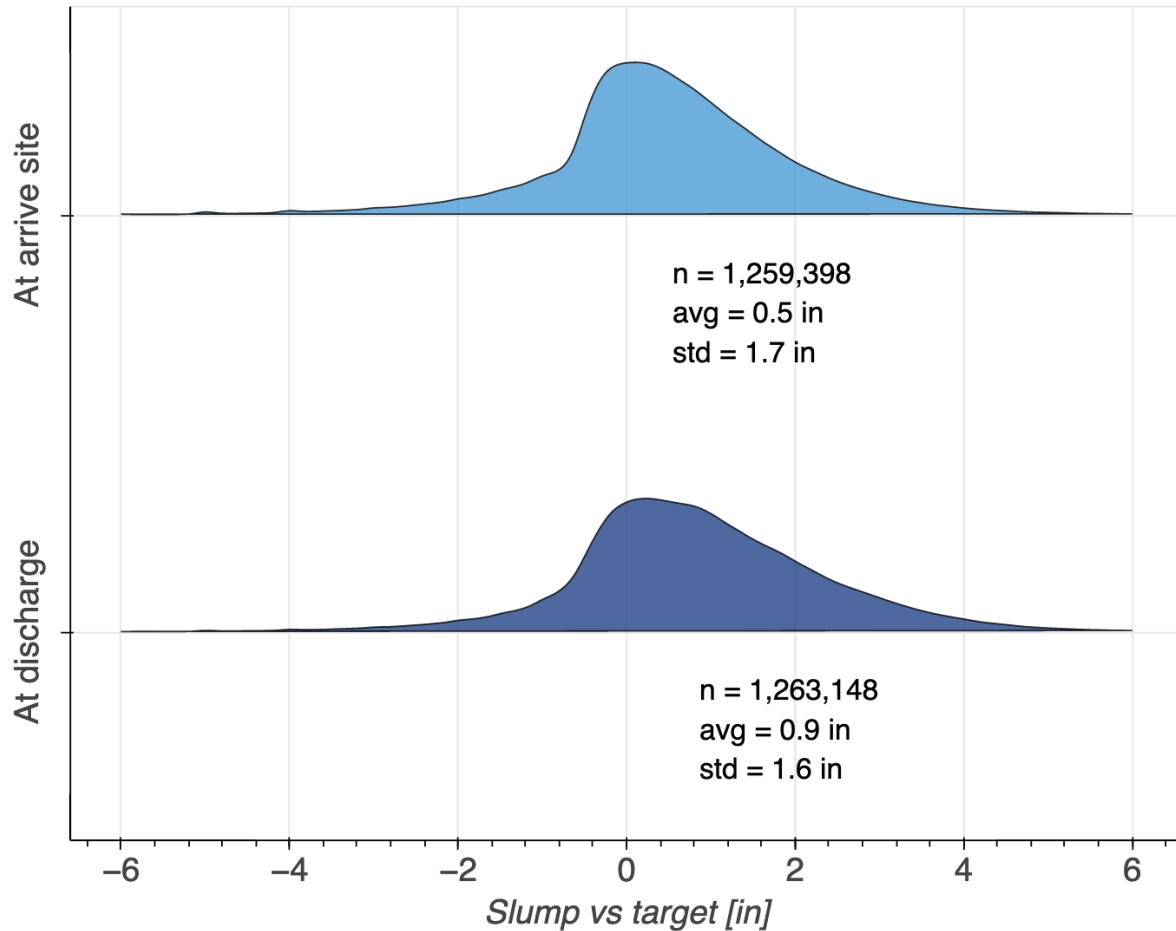


Feedback system /
Maintain slump

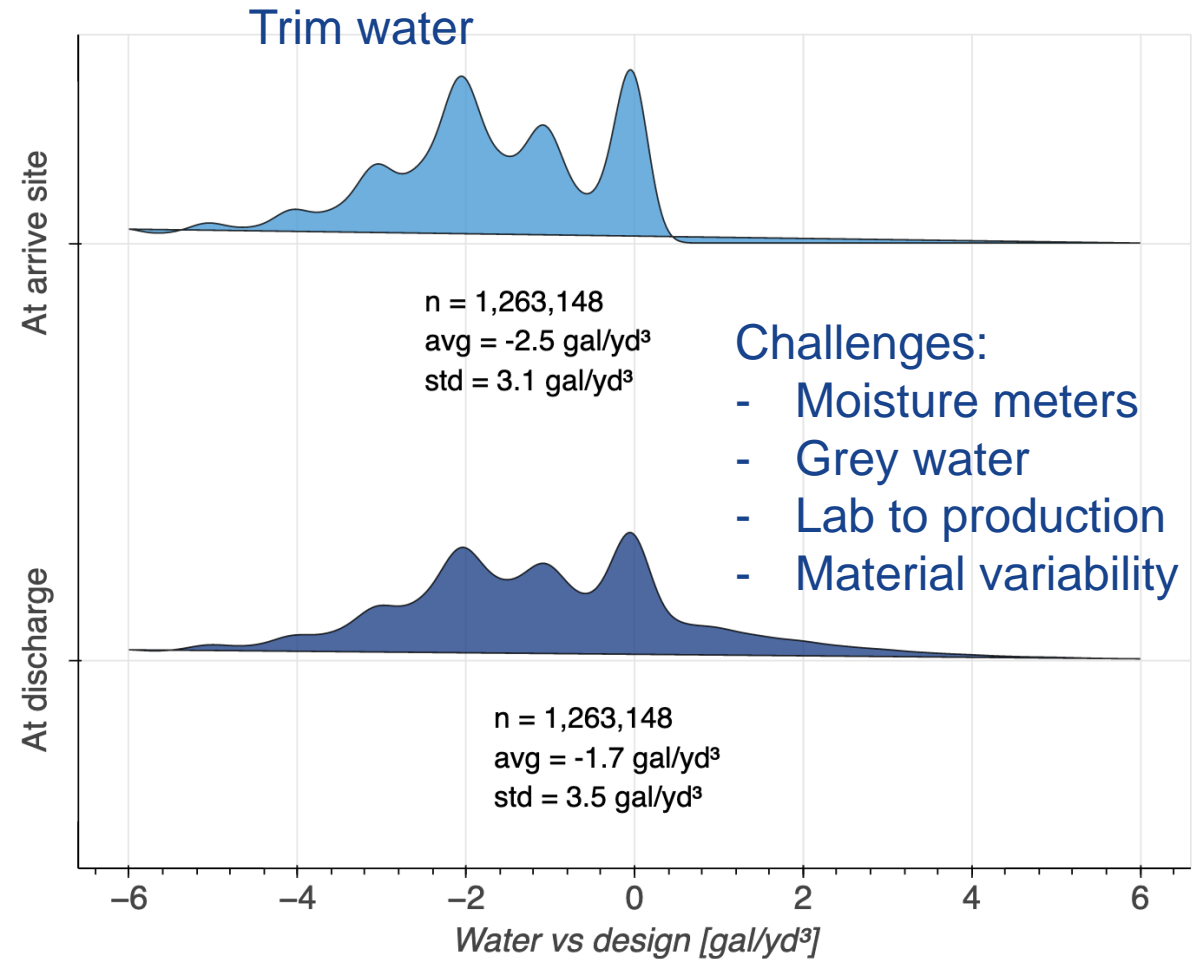
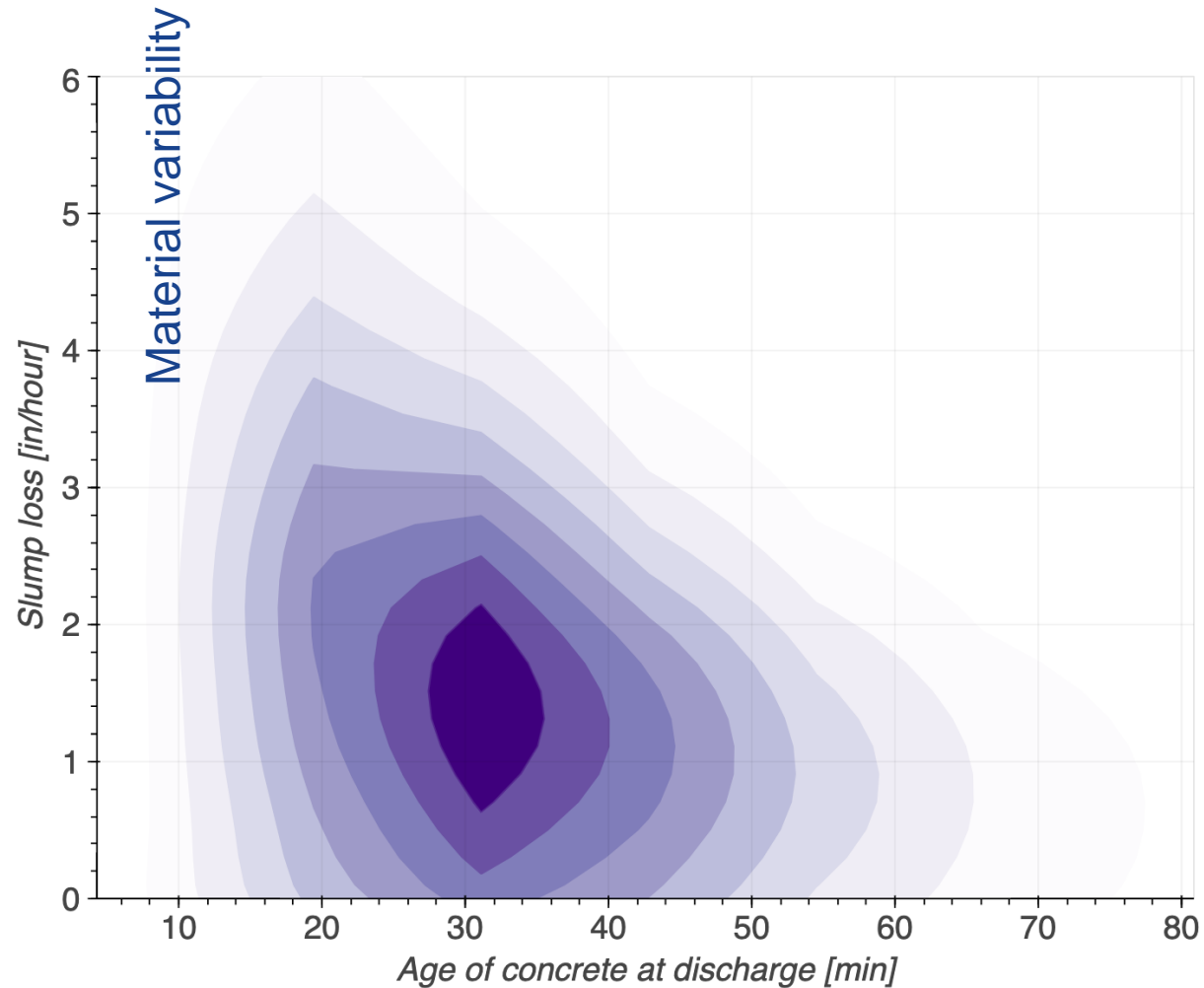


Feedback system /
Water/admix to **final slump**

LOADS THAT WERE MANUALLY ADJUSTED

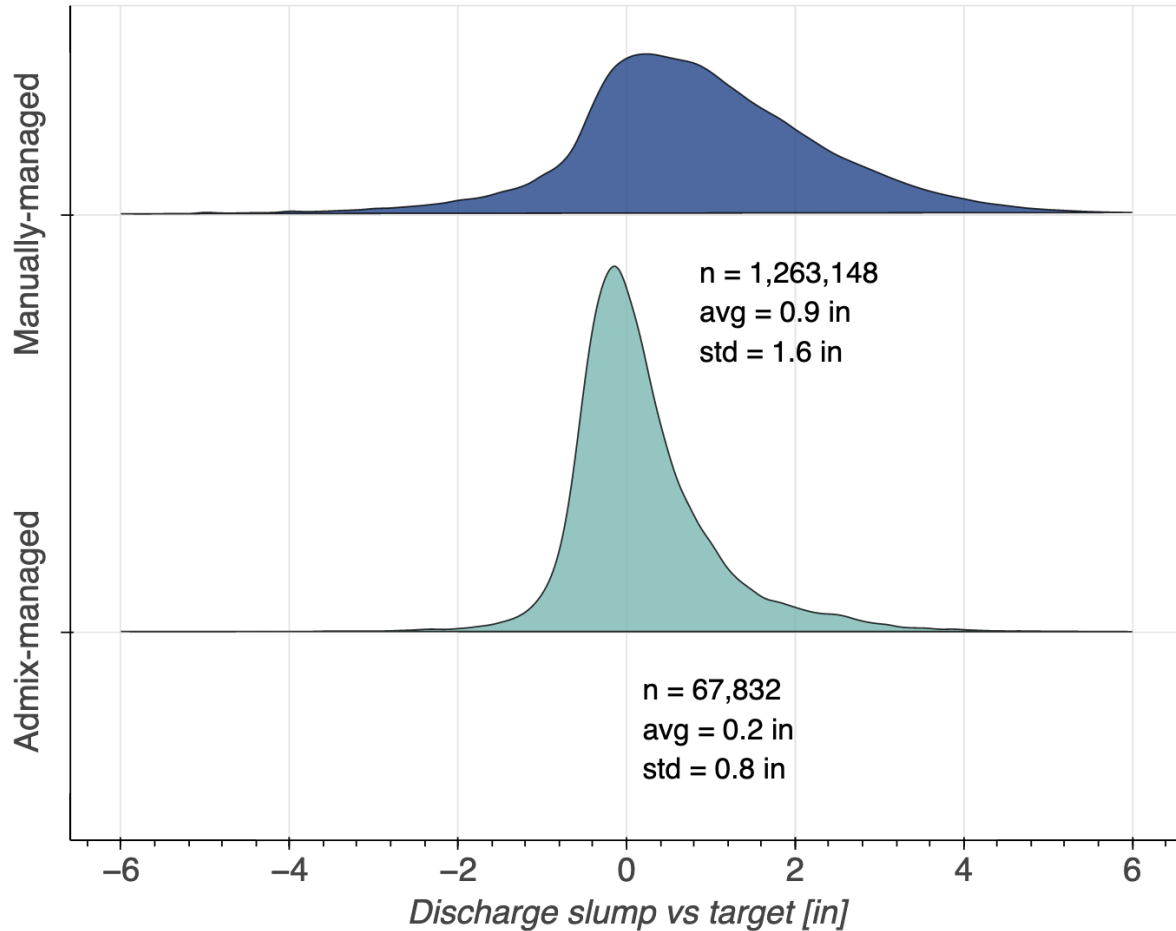


LOADS THAT WERE NOT MANAGED ON THE WAY TO THE JOBSITE

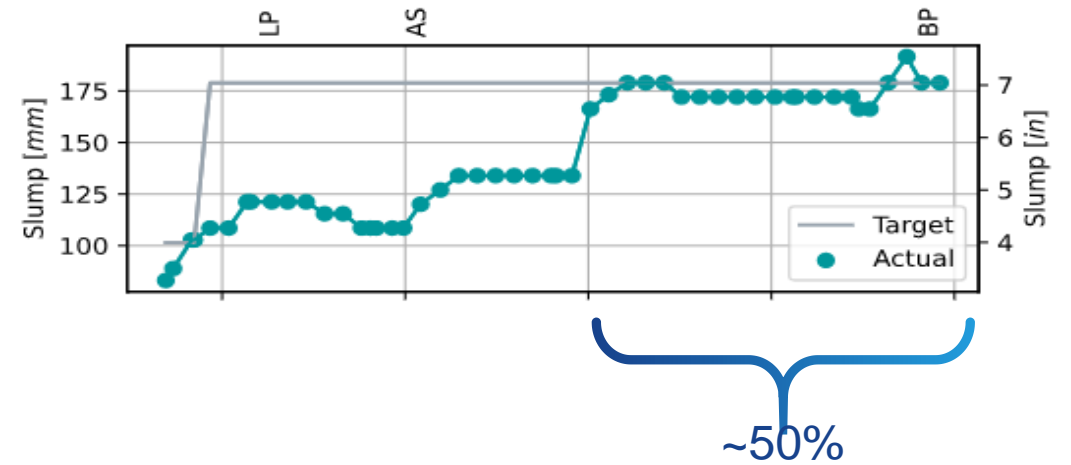


Traffic, jobsite delays

ADMIX-MANAGED COMPARISON



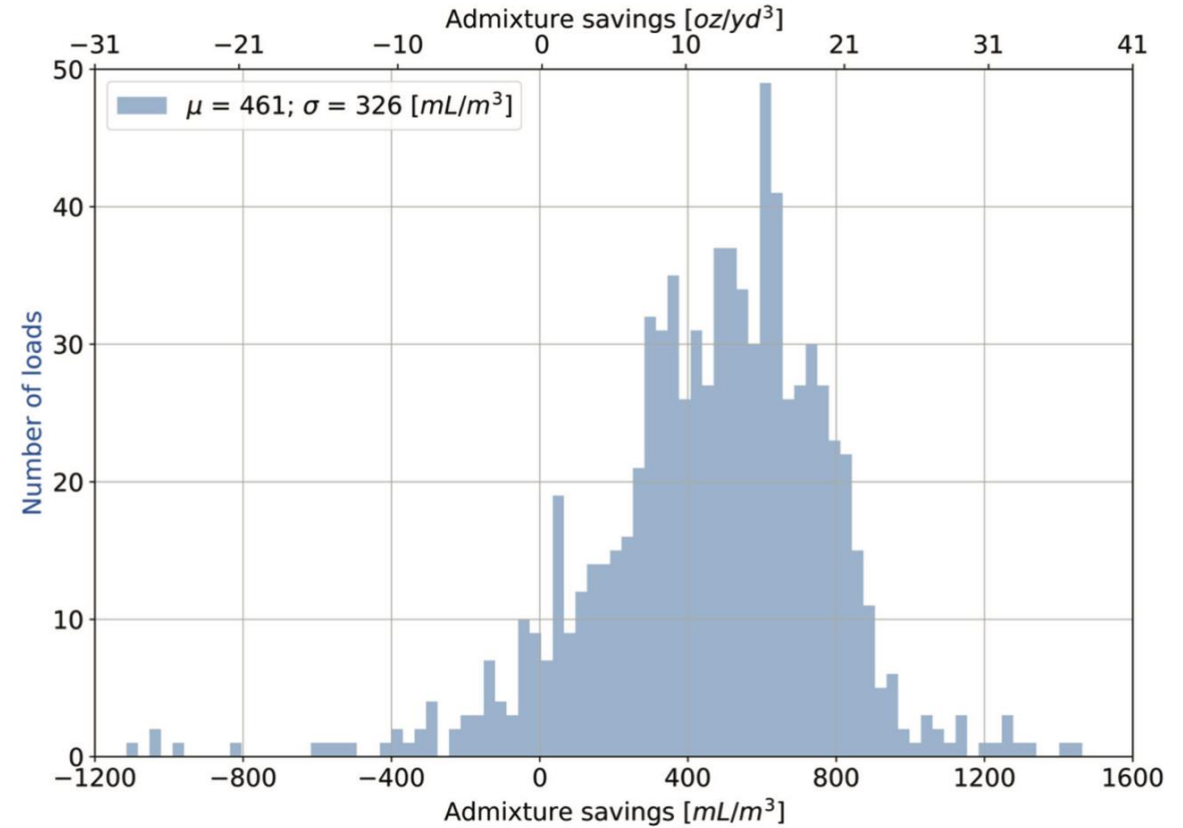
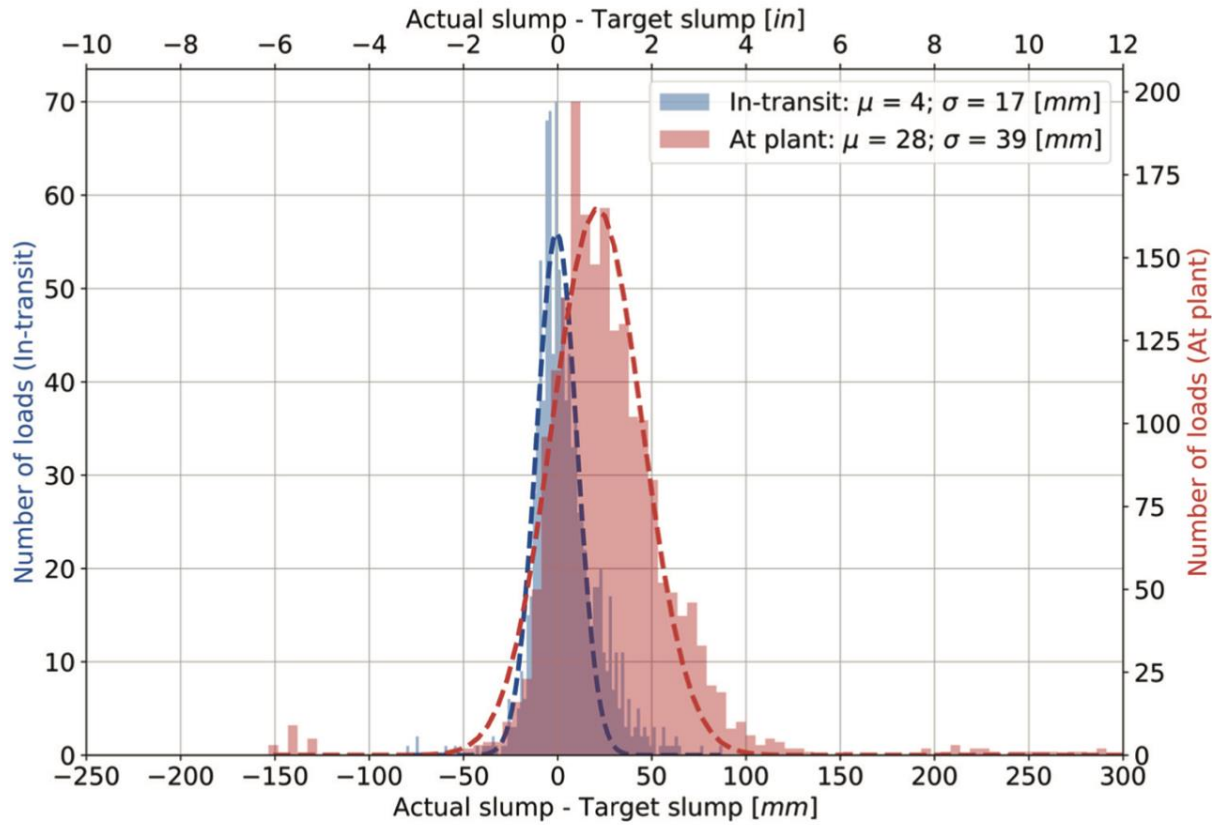
Percent of load that slump is within spec (between leave plant and end pour)



Last 3 months of data

	Manually- managed	Admix-managed
n	683	671
avg	58%	73%
std	41%	29%
Loads at 0%	26%	3%

ADMIX USAGE STUDY



ACI MATERIALS JOURNAL TECHNICAL PAPER

MS No. M-2020-467

Benefits of In-Transit Management Systems through Addition of Admixture

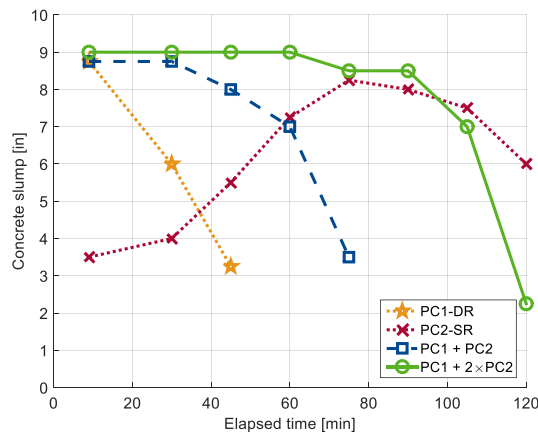
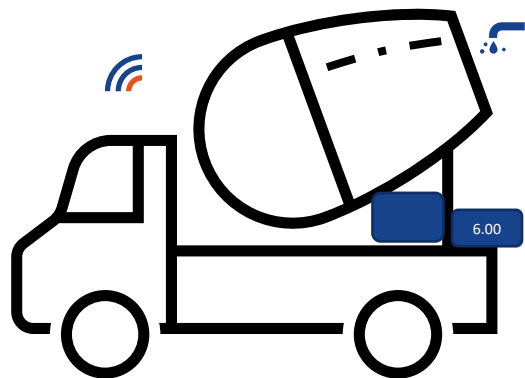
by Jason Straka, Stephen P. Klaus, Junfeng Zhu, Pete A. Gentile, and Nathan A. Tregger



CHEMISTRY + IOT

- Hitting the target slump is a real challenge involving many factors
- Having a *performance* feedback system can help RMX plants to manage the challenges
- Consistency benefits the producer as well as the contractor

“For the first time, you can add the right amount of admixture for that *individual load*.”



-Tom Greene





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