

## User Instruction

# CRUISECONTROL

## 1. Introduction

### 1.1 Important Safety and Usage Instructions for CruiseControl

**BEFORE** installing and operating CruiseControl, please read the user instructions carefully. Ensure that you understand all the information provided for proper use, carefully read these instructions to ensure proper use. All personnel involved in the installation and operation of the Concrete Batching System (CBS) must be trained according to local safety regulations and applicable EU Directives, including Directive 2009/104/EC and Directive 2006/42/EC.

### 1.2 Personal Protection Equipment (PPE)

For health and safety reasons, anyone involved in installing, uninstalling, operating, cleaning, or maintaining the Concrete Batching System must wear appropriate Personal Protection Equipment (PPE) in accordance with local regulations, and, where applicable, EU Regulation (EU) 2016/425. This includes, but is not limited to, gloves, safety glasses, hard hats, and safety shoes.

### 1.3 Continuous Improvement and Feedback

COBOD International is committed to delivering the highest degree of accuracy possible. As part of our policy of continuous improvement, product specifications may change without notice. We encourage readers and users to share their suggestions for improvements. All feedback will be carefully considered for future updates of this user instruction and potential changes to our products. Please send your feedback to [info@cobod.com](mailto:info@cobod.com).

## 2. Scope

This document provides guidance on using CruiseControl, an advanced feature available with the COBOD Concrete Batching System. CruiseControl enhances the system's performance by automating key processes, ensuring consistent concrete quality, and minimizing manual intervention.

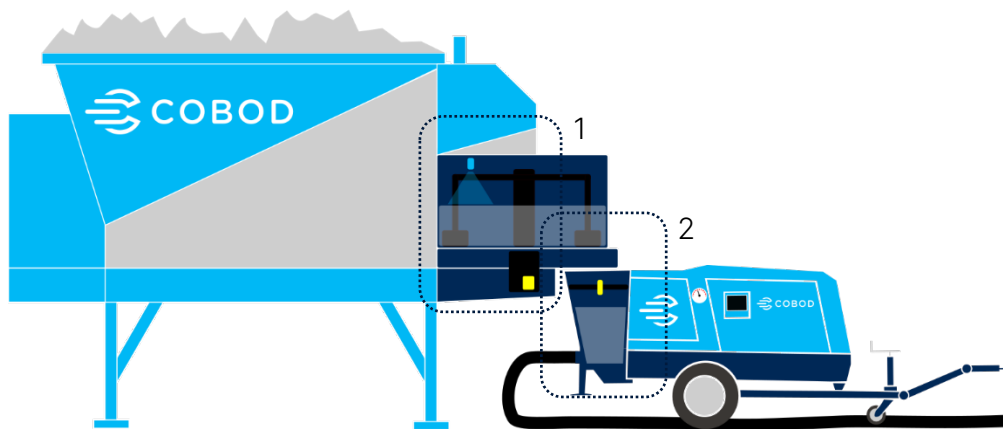
CruiseControl consists of two main components: ConsistencyControl and AutoEmpty. ConsistencyControl automatically adjusts plasticizer levels based on the mixer's torque, ensuring uniform concrete workability across batches. AutoEmpty manages the mixer gate to maintain optimal concrete levels in the pump's hopper, automatically initiating a new batch when needed.

### 3. Technical Specifications

| Specification         | Details                                                                       |
|-----------------------|-------------------------------------------------------------------------------|
| Sensor Model          | Microsonic Distance Sensor                                                    |
| Means of Measurement  | Echo Propagation Time Measurement                                             |
| Range                 | 85 mm to 600 mm   3.3 in to 23.6 in                                           |
| Operating Temperature | -25°C to +70°C   -13°F to +158°F                                              |
| Type of Connection    | 5-pin M12 initiator plug                                                      |
| Mounting Bracket      | Insert the distance sensor into the bracket and secure it on the pump's grid. |
| Bracket Dimensions    | 45 mm x 80 mm x 200 mm                                                        |



\*Illustration 1: Visualization of the Concrete Batching System (CBS) with the mounting bracket secured to the pump's grid.



\*Illustration 2: Visualization of the COBOD Mini Batch Plant and the COBOD Concrete Piston Pump.

| # | Component Name                | Description                                                                                                                                                                                                                                                                                                   |
|---|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Process 1: ConsistencyControl | ConsistencyControl is a software enhancement that dynamically adjusts the addition of plasticizers based on the mixer's torque. This results in more consistent concrete quality across different batches, improving workability and ensuring uniformity.                                                     |
| 2 | Process 2: AutoEmpty          | AutoEmpty is a hardware upgrade that automates the control of the batch plant's discharge gate, maintaining an optimal concrete level in the pump's hopper. By initiating a new batch when the mixing chamber is empty, AutoEmpty reduces the need for manual intervention, increasing efficiency and safety. |

## 4. Installation Guide

This section provides detailed instructions for installing the ConsistencyControl and AutoEmpty functions. Follow these steps carefully to ensure a safe and effective installation.

### 4.1 ConsistencyControl

#### 4.1.1 Installation Safety

- Perform a visual inspection of all parts before each installation/deinstallation.
- Ensure wearing appropriate Personal Protection Equipment (PPE).

#### 4.1.2 Preparation

Proper preparation is essential for successful installation. Ensure the following prerequisites are in place.

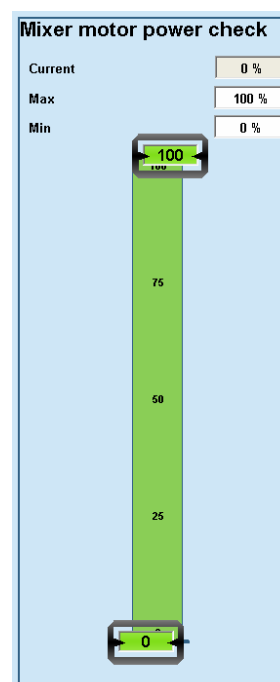
| Preparation   | Details                                                                                                                |
|---------------|------------------------------------------------------------------------------------------------------------------------|
| Prerequisites | Watt-meter control<br>A functional Chemical 1 dosing pump<br>Remote connection for updating the batch plant's software |

#### 4.1.3 Installation

##### 4.1.3.1 Hardware

Step 1: Ensure the required hardware is available.

1. No hardware is required on batch plants with watt-meter control.  
To verify, see [SETTINGS] > [MIXER AND GATE], under [MIXER MOTOR POWER CHECK]. The graphic should be visible.



### 4.1.3.2 Software Update

Step 1: Update the batch plant's software to the latest version.

1. The batch plant's software requires an update to the latest version, for which it must be connected to the internet and the machine needs to be operational during Denmark working hours for the update. Send an email to techsupport@cobod.com to arrange the HMI update, attaching a picture of the batch plant's machine plate and providing the TeamViewer password.
2. Ensure the batch plant is connected to the internet. This can be done by:
  - a. Buying a sim locally (with data) and inserting it into the router in the batch plant's e-box as shown in the picture below. Use sim slot 2, as sim slot 1 contains the sim used for remote support.
  - b. It is also possible to connect a Wi-Fi router via a LAN cable to the batch plant's router via ETH1 as seen below.



\*Illustration 3: Visualization of the batch plant's router.

### 4.1.4.2 Software

Step 1: Change the following settings in the HMI.

1. In [SETTINGS] > [WATER AND CHEMICAL], for Chemical pumps 1 and 2, set the [OFF-DELAY MEASUREMENT] to 0,1 s.
2. The chemical pumps can be calibrated by changing the [AFTERRUN] value. If the set point is exceeded, increase the [AFTERRUN] value. If the set point is not reached, decrease the [AFTERRUN] value.

| Chemical 1            |           | Chemical 2            |           |
|-----------------------|-----------|-----------------------|-----------|
| Afterrun              | 0.03000 l | Afterrun              | 0.05000 l |
| Max. dosage tolerance | 5.0 %     | Max. dosage tolerance | 5.0 %     |
| Max. run time         | 120 sec   | Max. run time         | 120 sec   |
| Flowpuls Scale Factor | 0.01000 l | Flowpuls Scale Factor | 0.01000 l |
| Off delay measurement | 0.100 s   | Off delay measurement | 0.100 s   |

3. In [SETTINGS] > [MIXER AND GATE], set the mixing speeds as in the image below. 60% for [DOSING], 120% for [MIXING] and 30% for [WAIT FOR EMPTYING] and [EMPTYING]. If the speed is too high, it can overload the motor that trips the circuit breaker. If this happens, reduce the mixing speed.
4. Under [WATTMETER CONTROLLED DOSING] set [CHEMICAL TO ADD] to 1 L/m<sup>3</sup> (plasticizer), and thereafter [RUNTIME AFTER DOSING] to mix for 30 s, as in the image below.

| Mixer                       |       |
|-----------------------------|-------|
| Dosing                      | 80 %  |
| Mixing                      | 120 % |
| Wait for emptying           | 30 %  |
| Emptying                    | 30 %  |
| Wattmeter controlled dosing |       |
| Water to add (per m3)       | 0.0 l |
| Chemical to add (per m3)    | 1.0 l |
| Runtime after dosing        | 30 s  |

## 4.2 AutoEmpty

### 4.2.1 Installation Safety

- Perform a visual inspection of all parts before each installation/deinstallation.
- Ensure wearing appropriate Personal Protection Equipment (PPE).

### 4.2.2 Preparation

Proper preparation is essential for successful installation. Ensure the following prerequisites are in place.

| Preparation   | Details                                     |
|---------------|---------------------------------------------|
| Prerequisites | Material Level Sensor<br>3D Printed Bracket |

### 4.2.3 Installation

#### 4.2.3.1 Hardware

**Step 1: Insert the Distance Sensor into the Mounting Bracket and Secure it on the Pump's Grid.**

1. A mounting bracket for the level sensor is required. The 3D file for the bracket is available on [COBOD Connect](#). The printing process takes approximately 7 hours, using PETG filament with 100% infill to ensure maximum durability.
2. Install the mounting bracket above the deepest part of the hopper, but not directly under the concrete discharge zone. It is preferable to secure the bracket as close as possible to the vibrator, between the two round girders on the bottom of the grid.
3. Consider using an M12 extension cable, as it can be useful but is not essential.



\*Illustration 4: Image of the mounting bracket secured on the pump's grid.

#### 4.2.3.2 Software

**Step 1: Adjust the Mixer Gate Settings in the HMI.**

1. In [SETTINGS] > [MIXER AND GATE], set [WEIGHT EMPTYING, OPEN FULL] to 100 kg and [EXTRA EMPTY TIME LAST BATCH] to 30 s.

| Mixer Gate                   |        |
|------------------------------|--------|
| Open halfway                 | 0.60 s |
| Weight emptying, open full   | 250 kg |
| Weight empty                 | 36 kg  |
| Extra empty time, last batch | 20.0 s |

## 5. Operations Guide

### 5.1 Software

#### 5.1.2 ConsistencyControl

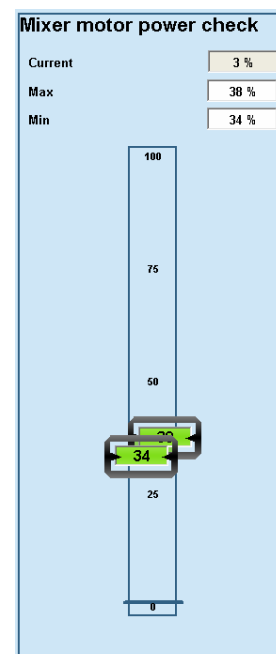
- ▶ In your typical D.fab [RECEIPT], reduce the plasticizer by 2 L/m<sup>3</sup>. In this way, plasticizer is retained from the original receipt, and added automatically during the modification phase.
- ▶ In Denmark, only 100 s of **mixing time** is required before the mixer torque stabilizes. Consequently, the mixing time is set to 100 s. Your mixer load might stabilize slightly later or earlier, depending on the mix and materials.

#### ▶ Set the Target Mixer Load.

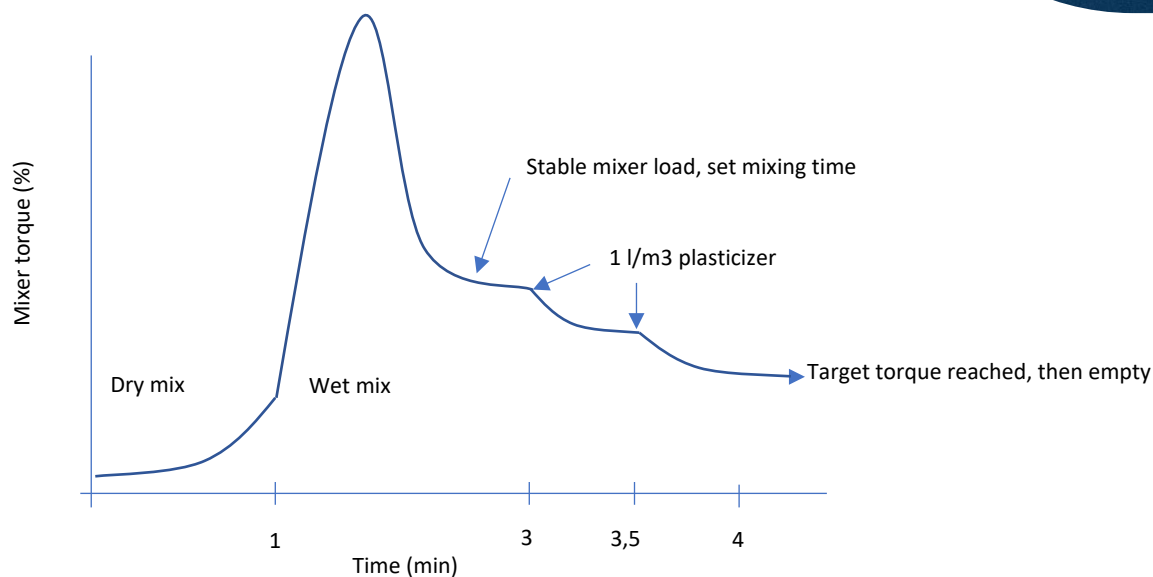
1. In [SETTINGS] > [MIXER AND GATE], under [MIXER MOTOR POWER CHECK], set the target mixer load minimum and maximum.

In Denmark of D.fab, the maximum and minimum values are set to 36% and 34% respectively for a 150 L batch. This corresponds to a shear vane value of 14 and 12 mm, respectively. However, as the mixer load depends significantly on the size and shape of the aggregates, your mixer load may be very different.

In the example, 38% and 34% were used.



- ▶ During the **dosing** phase, the raw materials are dosed and mixed at 80% speed. When the mixing speed increases to 120%, during the **mixing** phase, a peak occurs. If this peak trigger the circuit braker, decrease the mixing speed to 100% or even 80%.
- ▶ As the materials homogenize, the **mixer load decreases and stabilizes** 30 to 60 s after the peak. For the **shortest batching time**, the mixing time should be set to the first instance of a stable mixer load (plateau in the graph below).
- ▶ Once the mixing time is complete, the machine will automatically check if the mixer load is above the target value. If yes, **additional plasticizer is added**.
- ▶ If the **mixer load is higher than the target value**, plasticizer (from chemical pump 1) is added at the 1 L/m<sup>3</sup> dosage (as set in the settings).
- ▶ **Mixing will continue** for 30 s, as set in the settings. During this time a red light will flash next to the mixer load. After 30 s (as set in the settings), the actual mixing load is **again compared** to the target value.
- ▶ This process is **repeated** until the target value is reached.



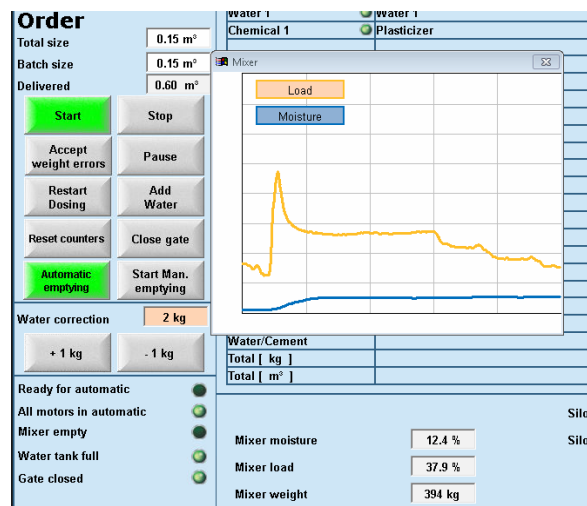
\*Illustration 5: Typical mixer torque graph.

► Display the Mixer Torque Graph.

1. Display this graph by clicking on the [MIXER LOAD VALUE] in the main screen. In the case below the mixer time was longer than needed as indicated by the long (2 min) stabilized mixer load after the peak. Reducing the mixing time by about 100 s would increase the production rate.

In this example, it should also be clear that additional plasticizer was added on three occasions.

It takes about 30 s for the mixer load to **stabilize after the additional plasticizer**. Hence, the use of 30 s mixing time after adding additional plasticizer.

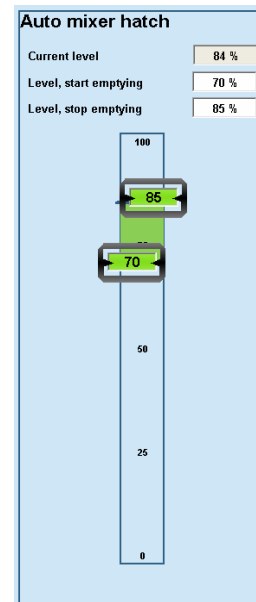


### 5.1.3 AutoEmpty

- ▶ The mounting bracket with the distance sensor should be mounted on the pump's grid.
- ▶ **Modify the Auto Mixer Hatch Settings.**

1. In [SETTINGS] > [MIXER AND GATE], under [AUTO MIXER HATCH], set the start emptying to 70% and stop emptying at 90%.

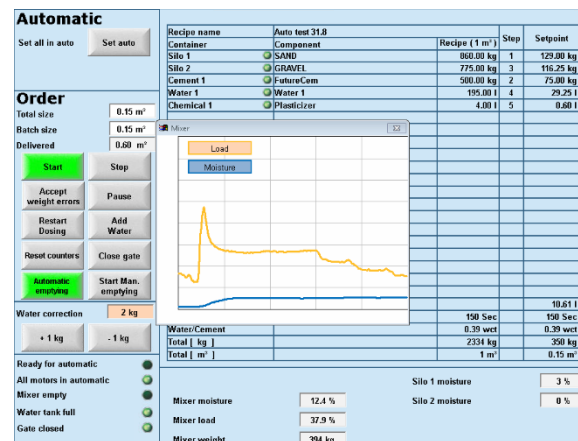
In the example, 70% and 85% were used.



- ▶ **Enable AutoEmpty feature.**

1. To enable AutoEmpty, activate the [AUTOMATIC EMPTYING] button before the batch is started. This will then enable the gate to open and close based on the distance sensor in the pump.
2. Setting the [TOTAL SIZE] to double the [BATCH SIZE], would enable the plant to start the next batch as soon as the mixer is empty. Two batches will be delivered. For example, a [TOTAL SIZE] of 0,45 m3 and [BATCH SIZE] to 0,15 m3 would produce 3 batch in succession.

**NOTE:** The position of the distance sensor on pump grid should not be changed after starting the mixing. This could affect the emptying time.



## 5.2 Printing Procedure

Utilize these automatic functions with the following procedure.

1. It is very important that the mixer chamber is **cleaned thoroughly daily**, as any buildup would affect the mixer load reading.
2. Determine the desired batch size for printing. The COBOD slicer gives an estimated [VOLUME PER HOUR] at the input print speed. For the desired batch size, divide this value by 5 (1200/5=240 L/batch). Therefore, making a new 240 L batch every 12 min.

| Model                     | Printer | Statistics |                                      |
|---------------------------|---------|------------|--------------------------------------|
| Total length              |         | 1.741,63m  |                                      |
| Print length              |         | 1.465,88m  |                                      |
| Rapid length              |         | 275,75m    |                                      |
| Estimated duration        |         | 2h 54m 32s |                                      |
| Estimated concrete volume |         | 2.931,68L  | Total length travelled by the nozzle |
| Layer count               |         | 25         |                                      |
| First layer Z             |         | 0,04m      |                                      |
| Last layer Z              |         | 1m         |                                      |
| Average layer time        |         | 6m 58s     |                                      |
| Min layer time            |         | 5m 51s     |                                      |
| Max layer time            |         | 10m 35s    |                                      |

| Layer | Print length | Rapid length | Duration | Print speed | Volume  | Volume per hour |
|-------|--------------|--------------|----------|-------------|---------|-----------------|
| 0     | 60,33m       | 10,34m       | 5m 51s   | 200mm/s     | 120,66L | 1.235,43L/h     |
| 1     | 60,33m       | 12,01m       | 5m 59s   | 200mm/s     | 120,66L | 1.209,41L/h     |

\*Illustration 6: COBOD Slice Overview

3. Use the **standard D.fab** receipt.
4. Prepare the first batch with the **desired batch size** (240 l) in this case.
5. **Calibrate** the batch by adding cement or water until the desired shear vane value has been reached.
6. The **target shear vane value** depends on experience and the original mix provided by COBOD during the Level 2 training. For reference, in Denmark a value of 12 mm is preferred during summer, while 16 mm is preferred during winter. In extremely hot climates, 10 or 8 mm might be preferred. Slump flow test can also be considered, and values 400-500 mm typically work well.
7. After the desired shear vane value has been achieved, **note the mixer load**. The mixer load is dependent on the batch size and mixer speed. Consequently, it is important to use the same batch size and mixer speed during calibration and printing.
8. Dump the first batch using the **manual emptying function**.
9. **Correct** the mix design based on the modification done in the first batch.
10. Prepare the second batch and **modify** until the desired shear vane value is reached.
11. **Note the mixer load** at the end of the mixing time.
12. **Dump** the second batch using the manual emptying function.
13. **Correct** the mix design based on the modification done in the second batch.
14. Additionally, **reduced the plasticizer dosage** by 2 L/m<sup>3</sup>. Therefore, some plasticizer is retained and added according to the mixer load.
15. Now, **set** the [MIXER MOTOR POWER CHECK] according to the mixer load of the previous batches (36% and 34% in our case). The ConsistencyControl function is now active.
16. Start the batch and **monitor** the mixer load graph to ensure that the mixing time is minimal, and that the plasticizer is added correctly.
17. Once the target mixer load has been reached, stop the mixer, and **check the shear vane value**.
18. **Dump** the third batch using the manual emptying function.
19. The [MIXER MOTOR POWER CHECK] can now be **adjusted** to make the next batch more or less fluid.
20. **Check** the shear vane on a few batches, while **adjusting** the [MIXER MOTOR POWER CHECK].
21. Use the **manual empty** until the ideal MIXER MOTOR POWER CHECK has been determined.
22. Now, **set** the AUTO MIXER HATCH values, AUTOMATIC EMPTY and increase the TOTAL SIZE. The batch plant will now deliver multiple batches until the TOTAL SIZE is achieved and empty each batch automatically.
23. Continue to **monitor** the process through the mixer load graph.
24. Since material build-up on the mixer arms could affect the mixer load, every 5 to 8 batches should be checked manually with the shear vane to ensure consistency and quality control.
25. Remember to check the **raw materials and additive quantities** often.

## 6. Conclusions

These functions should automate the majority of the manual process around mix modifications and emptying during printing. If you have problems with the system, please write to [techsupport@cobod.com](mailto:techsupport@cobod.com). Any feedback would also be appreciated.

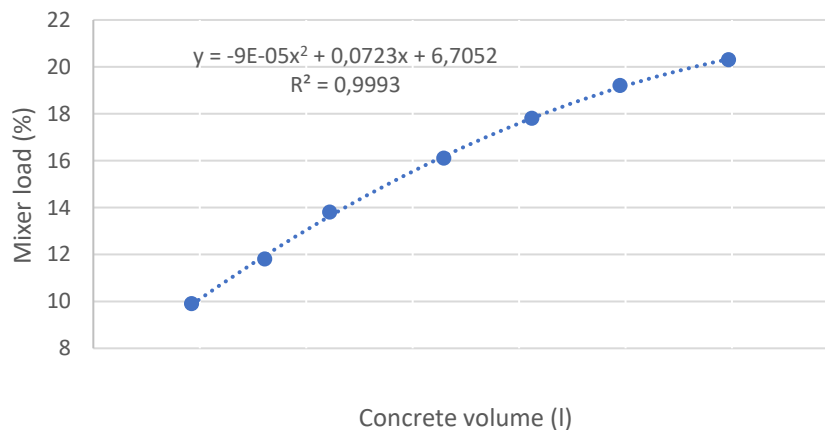
## 7. Appendix

### 7.1 Mixer Load Vs Concrete Volume

Since the relationship between mixer load and concrete volume depends significantly on the mix composition and raw materials, an experiment is required to determine the correlation. If a quick change in batch size is often required during printing, the following test is useful.

The following simple test can be used to determine the relationship between mixer load and concrete volume:

1. Prepare a 300 L batch of the standard receipt and note the mixer load at the set mixing speed.
2. Dump about 100 kg at a time and note the mixer load and mixer weight each time.
3. In Excel, convert the weight to a volume by dividing the weight by 2,3 (the density of concrete).
4. Plot the volume and mixer load in Excel with the concrete volume on the x-axis.
5. Fit an order 2 polynomial to the data and display the equation.
6. Any concrete volume can now be substituted into the x value to calculate the corresponding target mixer load.



\*Illustration 7: Relationship between mixer load and concrete volume.