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Second Revision

RECOMMENDED GUIDE SPECIFICATIONS
for
BATCHING EQUIPMENT AND CONTROL
SYSTEMS IN CONCRETE BATCH PLANTS



Prepared By

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FOREWORD

The Concrete Plant Manufacturers Bureau is an organization composed of member companies directly involved in the design, manufacture, and sale of concrete plant equipment. The function of the Concrete Plant Manufacturers Bureau is to establish minimum standards for rating concrete plant components for the protection and assurance to the user that purchased equipment conforms to these standards. The Bureau also provides a means for mutual consideration of matters common to the concrete industry whereby plant technology, user services, agency specifications, and related common problems can better be served through coordinated efforts of the Bureau members.

This publication is offered as a useful guide for specification writing covering batching equipment and batching controls to be used in concrete batch plants. All federal, state, and local agencies that contemplate issuance of new specifications are invited to use this guide in an effort to standardize requirements and to conform to the latest Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

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1. SCOPE

This guide is concerned with the specification writing for Batching Equipment, Batching Scales, Batching Tolerances, Batching Controls, and Batching Recordation. It is hoped that the subject matter contained in this guide will assist in establishing standardization among specifying agencies, such as federal, state, and local governments. Standardization will improve the quality of the equipment to be specified and ensure a more technically correct and practical specification for the production of quality concrete.

Depending on the type of work and concrete required, it is understandable that specifications will vary to achieve the proper equipment best suited to provide acceptable concrete under prevailing conditions.

The specification writer should consider certain criteria, such as accuracy, reliability, economics of equipment related to the quantity of concrete, and type of plant best suited for the quality and type of concrete required for the particular project. Basically, he must determine whether cumulative or individual aggregate batchers and automatic or semi-automatic control systems are required. Also to be determined is the necessity for interlocks and type of recording for confirmation or required

records. Selection of standardized equipment described in this guide will help reduce equipment costs, whereas specialized designs and generalizations in specification language should be avoided since they tend to increase the cost of equipment.

2. BATCHING EQUIPMENT

2.1 BATCHING EQUIPMENT SHALL PROVIDE THAT:

- cement or cementitious materials shall be batched by weight
- aggregates shall be batched by weight;
- water shall be batched by weight or volume;
- powdered admixtures shall be batched by weight; and
- liquid admixtures shall be batched by weight or volume.

2.2 SCALES

Scales for batching shall consist of a lever system suspending the weighing container and, by means of secondary levers, transmitting reduced loads to a beam scale with balance indicator or a full reading springless dial. The construction and accuracy of the scales shall conform to the applicable sections of the NIST Handbook 44-1995, "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices," except as

herein specified. Methods other than those specifically described in this paragraph that meet all weighing tolerances specified in these Standards are acceptable.

2.3 SCALE ACCURACY

When scales are first installed they shall be accurate to the basic tolerance values specified in NIST Handbook 44-1995 in Section T.N.3.4. The minimum tolerance shall be $\pm 0.1\%$ of the capacity of the scale or ± 1 division, whichever is less.

2.4 SCALE LEVER SYSTEMS

Scale lever systems shall be so designed to have a gross carrying capacity sufficient to support the fully loaded weighing container without loss of accuracy or abnormal wear and to have the center of gravity of the gross load on the scale always remain between the load pivots. The pivots shall be hard, tempered, sharpened, and gauged for sustained accuracy. The bearing loops shall be constructed with hardened bearing surfaces. Means shall be provided for leveling, aligning, balancing, and calibrating scale levers in the field.

2.5 BEAM SCALES

Beams for indicating the load shall include a zero balance beam, a balance indicator, and a weighing beam for

each ingredient used in any batch. Beams shall be precision constructed devices with properly hardened pivots and bearings capable of holding positive alignment. All poises shall have positive and accurate holding devices. All wearing parts of poises shall be hardened and protected against corrosion. The clear interval between beam graduations shall not be less than 0.03 in. (0.76 mm). The balance indicator shall be sufficiently sensitive to show movement when a weight equal to 1/10 of 1 percent of the scale capacity is placed in the batch hopper. Pointer travel shall show a minimum of 5 percent of the net rated capacity of the largest weigh beam for underweight and 4 percent for overweight. A readily adjustable mechanism shall be provided for dampening excessive oscillation of the indicator pointer.

2.6 DIAL SCALE

A dial scale mechanism shall be enclosed so as to be dust-tight. The dial pointer shall indicate the load in the batcher continuously from zero balance to the scale capacity. The chart shall be of durable material to ensure good readability. Charts used on the primary dial attached to the scale shall have a minimum of 1000 graduations placed on a circular reading line with a clear interval of not less than 0.03 in. (0.76 mm).

2.7 LOAD CELL SYSTEMS

Load cell systems shall be so designed to have a gross carrying capacity sufficient to support the fully loaded weighing container without a loss of accuracy or abnormal wear and to have the center of gravity of the gross load on the scale always remain between the load supports. A single load cell may be used with a scale lever system or multiple load cells may be used to support a weighing container. Load cell supports shall be designed to prevent any lateral or other nonaxial forces. Load cells shall be sealed for environmental protection. Load cell systems shall be designed to resist (a) moisture, (b) leakage resistance, (c) overload or shock damage, (d) drift from high voltage or high temperature, (e) line noise or radio frequency interference. A load cell system shall include a convenient means to allow the operator to check the condition and proper functioning of both the load cell circuit and the signal conditioning and load display circuit. A means may be provided to automatically check these circuits on a more frequent basis. Digital weight indicators shall be capable of reading full scale capacity and a maximum weight indication of 1/10 of 1 percent of full-scale capacity. Digital indications shall be clear, definite, accurate and easily read under all conditions of normal operation.

3. BATCHERS, GENERAL

A batcher shall consist of a suitable container for weighing an ingredient for concrete. A combination of aggregates or a combination of cements (or cement and other cementitious materials) may each be considered as a single ingredient. Aggregates and cement or cementitious materials shall not be weighed in the same batcher. Each batcher shall be equipped with a scale and also with the necessary mechanisms for its operation. The charging device shall be capable of stopping the flow of material within the weighing tolerances specified. Charging and discharging devices shall not permit loss of materials when closed. The discharge device shall be capable of controlling the rate of flow of the material.

When furnished, vibrators or other aids to charging and discharging shall be attached in such a manner that they will not affect accuracy of weighing.

The batcher shall be so designed and of such capacity that it will receive its rated load without the weighed material being in contact with the charging mechanism.

Volumetric capacities may exceed the minimum requirements. In use, the rated batcher capacity may be exceeded providing the load does not:

- (a) exceed the scale capacity;
- (b) overflow the batcher;
- (c) affect the scale by the closing of the charging device.

3.1 AGGREGATE BATCHERS

Aggregate materials shall be weighed in one or more cumulative batchers or in separate batchers provided for each material. There shall be sufficient clearance above the batcher to permit convenient removal of overload.

The reading face capacity or the sum of weighbeam capacities of a scale on an aggregate batcher shall be not less than 3,300 lb/yd³ (1960 kg/m³) of rated batcher capacity.

3.2 CEMENT BATCHERS (CEMENTITIOUS MATERIALS)

Cement and cementitious materials shall be weighed in one or more cumulative batchers or in separate batchers provided for each material. A dust seal shall be provided between the charging mechanism and the batcher, installed in such a manner that it will not affect the accuracy of weighing. The batcher shall be vented to permit escape of air. It shall be self-cleaning and may be fitted with a vibrator to ensure complete discharge. An overload removal port shall be provided.

The reading face capacity or the sum of weighbeam capacities of a scale on a cement batcher shall be not less than 660 lb/yd³ (392 kg/m³) of rated batcher capacity.

3.3 WATER BATCHER

Water can be weighed in a suitable hopper equipped with charging and discharging valves that shall close and seal to prevent loss of water. The charge and discharge connection shall not affect accuracy in weighing. Water shall not be weighed cumulatively with aggregates or cement and cementitious materials.

Scales for measuring the water may be graduated either in pounds (kg) or U.S. gallons (L) or both.

The minimum volume of the batcher tank, calculated from dimensioned drawings, shall be not less than its rated batcher capacity. Any water batcher shall have a volume providing not less than 40 U.S. gal/yd³ (198 L/m³) of concrete to be produced in a single batch.

The reading face capacity or the sum of weighbeam capacities of a scale on a water batcher shall be not less than 320 lb/yd³ or 38 gal/yd³ (190 kg/m³ or 188 L/m³) rated batcher capacities.

3.4 WATER METERS

Water may be batched through an acceptable metering device. A cutoff device shall be provided to stop the flow of water within the required tolerance and shall be free from leaks when closed. A suitable strainer shall be provided and installed ahead of the metering device. A register, integral with the meter, or a separate device to indicate the volume batched at any point in the metering operation, shall be provided. A volume setting device capable of being set to one-gallon increments or a register capable of being read to one gallon, or both, shall be provided. The metering device shall be capable of field adjustment for purposes of calibration.

3.5 DISPENSING EQUIPMENT FOR ADMIXTURES

Admixture dispensing equipment shall be subject to the following specifications: powdered admixtures shall be batched by weight, liquid admixtures may be batched by weight or volume, and the specifications shall be applicable only for dispensing admixtures having a minimum recommended dosage rate of one fluid ounce (or more) per 100 lb of cement (24.6 mL per 45.5 kg); or for concentrated additives that have been reconstituted to the point where the dosage rate is one fluid ounce (or more) per 100 lb of cement (24.6 mL per 45.5 kg).

The batching or dispensing devices shall be capable of repetitively controlling the batching of the admixture to the accuracy tolerances specified in these specifications. Piping for liquid admixtures shall be free from leaks and properly valved to prevent backflow or siphoning.

A separate dispenser is recommended for each admixture, although multiple use of dispensing controls is permitted and compatible admixtures may be stored in the same holding or checking reservoir after batching and prior to introduction into the mixer. If, contrary to this recommendation, the same dispensing equipment is used for non-compatible admixtures, the common device shall be flushed at the end of each cycle.

3.5.1 ADMIXTURE BATCHERS

Scales for admixture batchers may be graduated by weight or volume, with the minimum graduation being the amount or weight of the admixture required per 100 lb (45.4 kg) of cement.

Admixtures that are compatible may be cumulatively weighed in the same batcher providing the accuracy of batching of each is equivalent to the accuracy of batching required when each is batched individually.

Liquid admixtures that are compatible may be cumulatively weighed with the water providing that the accuracy of batching of each is equivalent to the accuracy of batching required when each is batched individually.

3.5.2 VOLUMETRIC ADMIXTURE DISPENSERS

All admixture dispensing equipment other than weigh batchers shall be classified as volumetric dispensers. All volumetric dispensers shall be used only for liquid admixtures and each plant shall be equipped with the necessary calibrated devices that will permit convenient checking of the dispenser volume to the required accuracy of the particular admixture.

The dispensing system shall include a device or devices that shall either detect and indicate the presence or absence of flow of the admixture; detect and indicate the presence or absence of the admixture or provide a convenient means of visually observing the admixture in process of being batched or discharged.

4. ACCURACY OF BATCHING

4.1 FOR INDIVIDUAL BATCHERS

For individual batchers, the following tolerances shall apply based on the required scale reading:

4.1.1 CEMENT AND OTHER CEMENTITIOUS MATERIALS⁽¹⁾

$\pm 1\%$ of the required weight of material being weighed OR $\pm 0.3\%$ of scale capacity, whichever is greater

⁽¹⁾*Other cementitious materials are considered to include fly ash and other natural or manufactured pozzolans.*

4.1.2 AGGREGATES

$\pm 2\%$ of the required weight of material being weighed OR $\pm 0.3\%$ of scale capacity, whichever is greater

4.1.3 WATER

$\pm 1\%$ of the required weight of material being weighed OR $\pm 0.3\%$ of scale capacity, whichever is greater

4.1.4 ADMIXTURES

$\pm 3\%$ of the required weight of material being weighed OR $\pm 0.3\%$ of scale capacity, OR

\pm the minimum dosage rate per 100 lb (45.4 kg) of cement, whichever is greater

4.2 FOR CUMULATIVE BATCHERS WITH TARE COMPENSATED CONTROL (See 5.5)

The tolerances of Paragraph 4.1 shall apply based on the required weight of each material.

4.3 FOR CUMULATIVE BATCHERS WITHOUT A TARE COMPENSATED CONTROL (See 5.5)

The following tolerances shall apply to the required cumulative weight.

4.3.1 CEMENT AND OTHER CEMENTITIOUS MATERIALS OR AGGREGATES

$\pm 1\%$ of the required cumulative weight of material being weighed OR $\pm 0.3\%$ of scale capacity, whichever is greater

4.3.2 ADMIXTURES

$\pm 3\%$ of the required cumulative weight of material being weighed OR $\pm 0.3\%$ of scale capacity, OR

\pm the minimum dosage rate per 100 lb (45.4 kg) as it applies to each type of admixture, whichever is greater.

4.4 FOR VOLUMETRIC BATCHING EQUIPMENT

For volumetric batching equipment the following tolerances shall apply to the required volume of material being batched:

4.4.1 WATER

$\pm 1\%$ of the required volume of material being batched OR ± 1 gallon (3.8L), whichever is greater

4.4.2 ADMIXTURES

$\pm 3\%$ of the required volume of material being batched OR \pm the minimum recommended dosage rate per 100 lb (45.4 kg) of cement, whichever is greater

4.5 RANGE OF ACCURACY

For ingredients batched by weight, the accuracy tolerances required of the batching equipment shall be applicable for batch quantities between 10 and 100% of scale capacity.

For water or admixtures batched by volume, the required accuracy tolerances shall be applicable for all batch sizes from minimum to maximum, as is determined by the associated cement or aggregate batcher rating.

5. BATCHING CONTROL SYSTEM

5.1 GENERAL

5.1.1. BATCHING CONTROL SYSTEM

shall be designated as follows:

- manual batching controls;
- manual batching systems;
- semi-automatic batching control for an individual visual batcher;
- semi-automatic interlocked batching control for an individual batcher;
- automatic batching control for an individual batcher;
- partially automatic batching system for multiple batchers and volumetric devices;
- semi-automatic batching system for multiple batchers and volumetric devices;
- automatic batching system for multiple batchers and volumetric devices;
- recorders.

5.1.2 BATCHING CONTROLS AND SYSTEMS

Batching controls are that part of the batching equipment that provides the means for controlling the batching device for an individual material. They may be mechanical, hydraulic, pneumatic, electrical, etc. or

combinations of these means.

A batching system is a combination of batching controls necessary to proportion the ingredients for concrete. A batching system may consist of controls for batching cement and aggregate only, if the mixing water is not added at the batching plant. Volumetric admixture batching controls are included in the scope of these specifications only when they are a part of a batching system.

Batching controls or systems shall be so located with respect to the batching equipment being controlled that visual monitoring for accuracy, calibration of controls and manual batching can be accomplished. If manual batching is not normally done, monitoring devices shall be sufficiently accurate to detect an error equal to the specified tolerance when a batch equal to the rated size of the batcher is batched.

Where batching controls or systems are remotely located with respect to the batching equipment, and manual batching is not normally done, monitoring devices shall be sufficiently accurate to detect an error equal to the specified tolerance when a batch equal to the rated size of the batcher is batched.

Where batching controls or systems are remotely located with respect to the batching equipment, follower scales or

other remote monitoring devices may be used for manual batching if they repeat the reading of the master scale within $\pm 0.2\%$ of scale capacity.

5.2 MANUAL CONTROLS

Manual control exists when the batching devices are actuated manually with the accuracy of the batching operation being dependent on the operator's visual observation of a scale or volumetric indicator. The batching devices may be actuated by hand or by pneumatic, hydraulic, or electrical power assists.

5.3 SEMI-AUTOMATIC BATCHER CONTROLS

When actuated by one or more starting mechanisms, a semi-automatic batcher control shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached. No interlocks are required.

5.4 SEMI-AUTOMATIC INTERLOCKED BATCHER CONTROLS

When actuated by one or more starting mechanisms, a semi-automatic batcher control shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached, interlocked in such a manner

that the discharge device cannot be actuated until the indicated material is within the applicable tolerances.

5.5 AUTOMATIC BATCHER CONTROLS

When actuated by a single starting signal, an automatic batcher control shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached, interlocked in such a manner that:

- the charging device cannot be actuated until the scale has returned to zero balance within $\pm 0.3\%$ of the scale capacity;
- the charging device cannot be actuated if the discharge device is open;
- the discharge device cannot be actuated if the charging device is open; and
- the discharge device cannot be actuated until the indicated material is within the applicable tolerances.

A tare compensated control is one that treats the start of the weighing of each ingredient as zero.

For cumulative batchers with tare compensated controls, interlocked sequential controls shall be provided, and the applicable tolerances shall apply to the required weight of each individual material.

For cumulative batchers without tare compensated controls, interlocked sequential controls shall be provided, and the applicable tolerances shall apply to the required cumulative weight of material as batched.

5.6 AUTOMATIC VOLUMETRIC CONTROLS

Automatic volumetric controls for water or admixtures, when actuated by a single starting signal, shall start the batching operation and stop automatically when the designated volume has been reached. The batching control shall include visual means of observing either the quantity set or the quantity batched, and an indication of the completion of the batching operation.

5.7 MANUAL BATCHING SYSTEM

A manual batching system shall consist of the required combination of individual manual batcher controls.

5.8 PARTIALLY AUTOMATIC BATCHING SYSTEM

A partially automatic batching system shall consist of the required combination of batching controls, at least one of which shall be for controlling the cement or aggregates, either semi-automatically or automatically. Inclusion of admixture controls is optional. Interlocking in any degree shall be optional.

5.9 SEMI-AUTOMATIC BATCHING SYSTEM

A semi-automatic batching system shall consist of the required combination of semi-automatic interlocked batching controls or of semi-automatic interlocked and automatic batching controls. Inclusion of admixture controls is optional, unless the admixture batching is initiated by the act of batching one of the other ingredients. Interlocking in any degree shall be optional.

5.10 AUTOMATIC BATCHING SYSTEM

An automatic batching system shall consist of the required combination of automatic batching controls.

All batching equipment in the system for batching ingredients by weight must be activated by a single starting mechanism. A separate starting mechanism is permitted for volumetric batching of water and/or admixtures not batched at the time of weighing.

Each automatic batcher must return to zero tolerance, and each volumetric device must reset to start or signal empty before it may be charged.

The discharge of any ingredient from the system may not start unless all batching controls have been cleared of the previous batch, the scales

returned to zero tolerance, and volumetric devices reset to start or signal empty. The discharge into the mixer of any scale may not start until all weighed ingredients have been batched in that scale.

Provisions shall be made for adjusting the sequential discharge of the batchers or measuring devices and the rate of discharge of materials.

6. BATCHING RECORDERS, GENERAL

A batching recorder may be either graphic or digital as described in the following paragraphs. All batching recorders shall produce a record of the batch weights or volume of each material requiring recordation, a batch identification or a batch count, day, month, year, time of day to the nearest minute and shall register empty balance.

Any automatically produced permanent record including the above minimum information shall be considered as an acceptable batching record.

6.1 GRAPHIC RECORDER

A graphic recorder is an instrument that scribes a line on a graphic chart simultaneously with the indication of the scale as the materials are being

weighed. Each scale may have its own recorder, or a series of scales may simultaneously record on a single graphic chart.

The housing shall be capable of being locked and the batch weights or volumes observed without unlocking.

The chart for each scale to be recorded shall not be less than 4 in. (102 mm) wide and shall have at least one line for each 2% of scale capacity; but not more than 25 lines per in. (one line per mm). The graphic record shall correspond to the reading on the scale within \pm one graduation of the recorder.

6.2 DIGITAL RECORDER

A digital recorder is an instrument that prints the weight or volume of a material or materials. The recording of each material may be done after each material is properly batched or after the total batch has been properly batched.

Each measuring device may have its own recorder or a series of measuring devices may record on the same tape or ticket. A digital recorder shall reproduce the reading of the scale being recorded within $\pm 0.1\%$ of scale capacity and one increment of any volumetric batching devices.

6.3 DIGITAL BATCH DOCUMENTATION RECORDER

A digital batch documentation recorder shall record the required information for each material in the total batch, identifying each material used along with a mix formula identification, the size of the total batch or load (commercial units) and an identification of the production facilities. Where certain required information is unchanged from batch to batch, it may be preprinted, stamped, or written on the record. The load may be identified by a batch count number or a ticket serial number or both. The recorder shall be capable of producing at least two documents of the record. If the recorder is interlocked to an “automatic batching system” as defined in these specifications, a single indication of all batching devices meeting the zero or empty balance interlocks shall be sufficient.

6.4 DIGITAL CONCRETE CERTIFICATION RECORDER

A digital concrete certification recorder shall produce at least two tickets of the batch or load, which in addition to the information required in the preceding paragraphs, shall include the percent of sand moisture compensation, identification of the purchaser, his job or project, and/or the particular placement location of the concrete. Space shall be provided for the identification of the delivery vehicle (truck number), the driver’s signature, the signature of the purchaser or his representative receiving the concrete, and the amount of water added on the job.

NEED HELP????

It is the policy of the Bureau to make its services available to all specifying agencies on problems involving those specifications allied with concrete plant equipment. Requests for assistance can be made by contacting any Bureau member or the Executive Secretary of the Bureau at its headquarters in Silver Spring, Maryland.

OTHER CPMB PUBLICATIONS

- *CPMB 100-00, Concrete Plant, Control Systems and Plant Mixer Standards of the Concrete Plant Manufacturers Bureau (inch-pound version)*
- *CPMB 100M-00 Concrete Plant, Control Systems and Plant Mixer Standards of the Concrete Plant Manufacturers Bureau (metric version)*
- *CPMB 101-01, Bin or Silo Capacity Rating and Method of Computation*
- *CPMB 104-99, Concrete Plant Operators Manual*

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