Volumetric Proportioning of Rapid Strength Concrete

Rapid Strength Concrete (RSC) is primarily used for rehabilitation work with tight timelines, to minimize impacts to the traveling public. Two types of cement are allowed for use in RSC: Type III or hydraulic. Refer to Contract Specifications (*CS*), Section 90-3.02A, *Concrete – Rapid Strength Concrete – Materials – General*. Choosing which to use may depend on project requirements and is typically at the contractor's discretion. RSC can be designed to achieve early strength and workability as needed.

One of the challenges with RSC is mixing and transporting the material to the project site. RSC sets up fast and using the traditional drum mixer can be difficult. The *CS*, Section 90-1.02G, *Concrete – Materials - Mixing and Transporting Concrete*, allow several methods for mixing and transporting concrete. Per the *CS*, Section 90-3.02B, *Concrete – Rapid Strength Concrete – Volumetric Proportioning,* volumetric proportioning using volumetric mixers as shown in Figure 1, is allowed in mixing and transporting RSC. For some cases, volumetric mixing is more cost and time efficient than traditional drum mixing, making these mixers an innovative solution for concrete production.

Figure 1. Volumetric Mixers

Volumetric Proportioning of Rapid Strength Concrete

Volumetric Mixers

The volumetric concrete mixer is a combination materials transporter and mobile concrete mixing plant, mounted on a transport vehicle or a stationary skid mount frame. The mixer carries the component materials of coarse aggregates, sand, cement powder and water, used to produce fresh concrete. These materials can be mixed along with other admixtures to produce a specified concrete mix design, on a continuous or intermittent basis, on site where the mix is to be poured. The mix is proportioned using known volumes of the component materials in the mix design.

The coarse aggregate and sand volumes are proportioned by adjusting the corresponding bin gates to the desired height as determined by a yield calibration test of the machine. The cement powder is accurately blended with aggregate using a uniquely designed auger delivery system. Finally, a metered amount of water is pumped into the mixing discharge chute and mixing auger to combine with the aggregates and cement powder.

Once in the discharge chute, the mixing auger continuously and thoroughly mixes and blends the ingredients to produce a continuous discharge of uniform quality concrete.

The volumetric mixer can be used alone, or it can be used as part of a concrete batching system. In Figure 2, a volumetric mixer is used to mix the concrete; it is then belted into a drum truck where admixtures are added before being transported to the pour site. Refer to Figure 3, for a schematic of a volumetric mobile mixer.

Figure 2. Volumetric Mixer belted into Drum Truck

Volumetric Proportioning of Rapid Strength Concrete

Volumetric mixers have other advantages. For example, volumetric mixers can:

1. Store, proportion, mix and dispense concrete from a single truck.
2. Allow quick and efficient mix design changes.
3. Produce a fresh mix upon delivery because all materials are kept separated until seconds before pouring.
4. Enable the user to move between jobs without having to return to a plant to change mix designs or reload.
5. Enable the user to eliminate overages and shortages and produce the exact amount of product needed.
6. Eliminate “hot” loads by ensuring fresh concrete is always available.
7. Consistently produce the exact mix design every time.
8. Increase efficiency with quick and easy clean out with no waste.
9. Enable the user to mix concrete anytime, day or night.

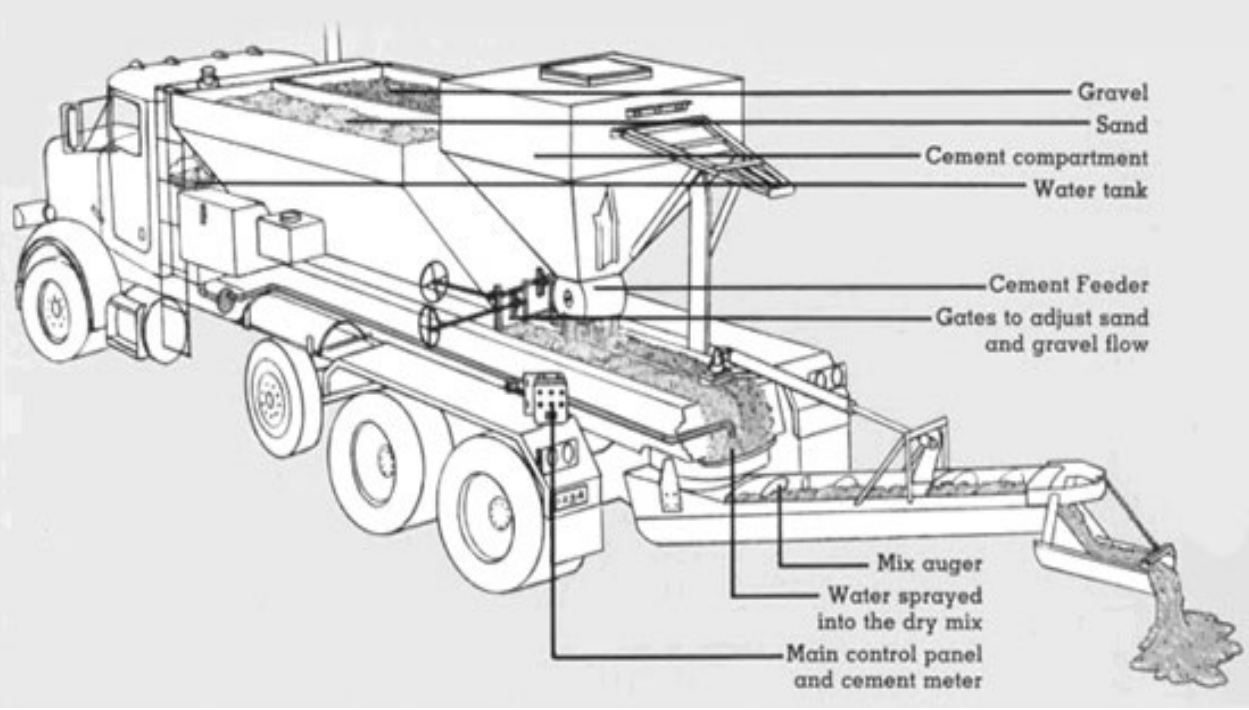

Figure 3. Schematic of a Volumetric Mobile Mixer

Volumetric Proportioning of Rapid Strength Concrete

Quality Assurance/ Quality Control when using RSC and Volumetric Mixers

When using a volumetric mixer with RSC, a mock-up is helpful in determining what type of equipment and material best suits the specific project (refer to Figure 4). A full-size section representing the work is preferable. During the mock-up, various parameters and unknowns may be determined. The following should be considered for a mock-up:

1. The mock-up should represent a full-size portion of work to be performed.
2. Reinforcement should be included.
3. All equipment and labor used in the mock-up should be the same as used in production.
4. The volumetric mixer should be certified (CT 109) using the same mix design that will be used in production work. For any material change from the approved mix design, the volumetric mixer must be recalibrated/recertified.
5. Concrete mix design with different dosage admixtures should be used to determine which mix design best suits the project for workability and set time.
6. If the concrete mix is for mass concrete (for example, when one dimension of a concrete member exceeds 7 feet), the mock-up should be used to determine peak temperature (must not exceed 160 degrees Fahrenheit) per *CS*, Section 51-6.01D(2)(b), *Concrete Structures – Mass Concrete – General - Quality Assurance – Quality Control - Temperature Monitoring* and temperature differential. For additional information refer to the *Concrete Technology Manual*, Chapter 1, *Structure Concrete Characteristics*, in the section titled, *Heat of Hydration*, on page 1-9. Note hydraulic cement will have different heat of hydration than portland cement.
7. Contractors may choose to prequalify the mix design during the mock-up. Refer to the *CS*, Section 90-1.01D(5)(b), *Concrete-General-Quality Assurance-Compressive Strength - Prequalification*. Contractors may also want to experiment with different types and dosages of admixtures (could include accelerators for Type III, or retarders for hydraulic cement) to achieve desired strength at age of break.

Volumetric Proportioning of Rapid Strength Concrete

Figure 4. Volumetric mixer staging with pump truck pumping into a mock-up

Quality Assurance during Production

During the work, it is important that quality assurance measures are taken to ensure proper production and placement of concrete. These measures include the following:

1. Volumetric mixers are tested, inspected, and certified (CT 109, *Method for Testing of Material Production Plants*) by Caltrans Weights and Measures prior to use.
2. All material stockpiles should be covered properly.
3. Sample aggregate stockpile for moisture content.
4. Sample aggregate stockpile for gradation.
5. Observe volumetric mixer and pump settings and operations using calibrations provided by Caltrans Weights and Measures.

Volumetric Proportioning of Rapid Strength Concrete

Figure 5. Concrete unit weight test

6. Take the unit weight by certified personnel and equipment toward the beginning of each separate placement (CTM 518, *Method of Test for Density (Unit Weight) of Fresh Concrete*). See Figure 5.
7. Measure the penetration by certified personnel (CTM 533, *Method of Test for Ball Penetration in Fresh Portland Cement Concrete*).
8. Determine the temperature of freshly mixed concrete by certified personnel (CTM 557, *Method of Test for Temperature of Freshly Mixed Hydraulic Cement Concrete*).
9. Sample sets of compressive strength cylinders by certified personnel.
10. Observe concrete placement for proper placement and consolidation.
11. Check weighmaster tickets and certificates of compliance.
12. Have the competent cement representative on site during concrete production.
13. Have the competent volumetric mixer representative on site during concrete production.