CLAIMS

What is claimed is

1. A method of preparing a concrete mix comprising

(i) adding concrete materials to a mixer;

(ii) adding mix water to the mixer, wherein the mix water comprises carbonated concrete wash water; and

(iii) mixing the water and the concrete materials to produce a concrete mix.

2. The method of claim 1 wherein the carbonated concrete wash water comprises at least 10% of the total mix water.

~~3. The method of claim 1 or 2 wherein the carbonated concrete mix water comprises at least 40% of the total mix water.~~

~~4~~3. The method of any one of claims 1 to 3 wherein the mix water comprises a first portion of water that is not carbonated mix water and a second portion of mix water that comprises carbonated mix water, wherein the first batch of mix water is added to the concrete materials before the second batch of mix water.

~~5~~4. The method of ~~claim 4~~claim 3 wherein the first portion of water is added at a first location and the second portion of water is added at a second location, wherein the first and second locations are different.

~~6~~5. The method of ~~claim 5~~claim 4 wherein the second location is the drum of a ready-mix truck.

~~7. The method of any one of claims 4 to 6 wherein the second portion of mix water is added at least 2 minutes after the first portion.~~

~~8~~6. The method of any one of claims 1 to ~~5~~7 wherein the carbonated concrete wash water has a density of at least 1.10 g/cm^3.

~~9~~7. The method of any one of claims 1 to ~~6~~8 wherein the carbonated concrete wash water has been held for at least 1 day.

~~10. The method of any one of claims 1 to 9 wherein the carbonated concrete wash water has been held for at least 3 days.~~

~~11~~8. The method of any one of claims 1 to ~~7~~10 wherein the concrete mix is sufficiently workable for its intended use, and the carbonated wash water is of an age that the same mix made with the wash water of the same age in the same proportions would not be sufficiently workable for its intended use.

~~12~~9. The method of any one of claims 1 to ~~8~~11 wherein the mix water comprises carbonated wash water in an amount that results in a concrete mix that is at least 5% stronger at a time after pouring than the same concrete mix made without carbonated wash water.

~~13. The method of claim 12 wherein the time after pouring is 1 day, 7 days, 28 days, or any combination thereof.~~

~~14~~10. The method of any one of claims 1 to ~~9~~13 wherein the mix water comprises carbonated wash water in an amount that allows the concrete mix to contain at least 5% less cement than, and retain a compressive strength after pouring of within 5% of, the same concrete mix made without carbonated wash water and with the extra 5% cement.

~~15~~11. An apparatus for carbonating wash water produced in the production of concrete in a wash water operation wherein the wash water comprises cement and/or supplementary cementitious materials (SCM), comprising

(i) a source of carbon dioxide;

(ii) a first conduit operably connected to the source of carbon dioxide that runs to a wash water container, wherein

(a) the wash water container contains wash water from a concrete production site;

(b) the conduit has one or more openings positioned to deliver carbon dioxide at or under the surface of the wash water in the container to produce carbonated wash water;

(iii) a system to transport the carbonated wash water to a concrete mix operation where the carbonated wash water is used as mix water in a concrete mix.

~~16~~12. The apparatus of ~~claim 15~~claim 11 further comprising

(iv) a controller that determines whether or not, and/or how, to modify delivery of carbon dioxide to the wash water, or another characteristic of the wash water operation, or both, based on the one or more characteristics of the wash water or wash water operation.

~~17~~13. The apparatus of ~~claim 16~~claim 12 further comprising

(v) one or more sensors that monitor one or more characteristics of the wash water and/or the carbonation of the wash water in the container, wherein the one or more sensors is operably connected to the controller and delivers information regarding the characteristic of the wash water and/or wash water operation to the controller, and, optionally,

(vi) one or more actuators operably connected to the controller to modify delivery of carbon dioxide to the wash water, or another characteristic of the wash water operation, or both.

~~18~~14. The apparatus of ~~claim 16 or 17~~claim 12 wherein the characteristic is

(a) pH of the wash water,

(b) rate of delivery of carbon dioxide to the wash water,

(c) total amount of wash water in the wash water container,

(d) temperature of the wash water,

(e) specific gravity of the wash water,

(f) concentration of one or more ions in the wash water,

(g) age of the wash water,

(h) circulation rate of the wash water,

(i) timing of circulation of the wash water,

or any combination thereof.

~~19~~15. The apparatus of ~~claim 17 or 18~~claim 13 wherein the sensor is one or more of a sensor for monitoring

(a) pH of the wash water,

(b) rate of delivery of carbon dioxide to the wash water,

(c) total amount of wash water in the wash water container,

(d) temperature of the wash water,

(e) specific gravity of the wash water,

(f) concentration of one or more ions in the wash water,

(g) age of the wash water,

(h) circulation rate of the wash water,

(i) timing of circulation of the wash water,

or any combination thereof.

~~20. The apparatus of any one of claims 16 to 19 further comprising~~

~~(iii) one or more actuators operably connected to the controller to modify delivery of carbon dioxide to the wash water, or another characteristic of the wash water operation, or both.~~

~~21~~16. An apparatus for preparing a concrete mix comprising

(i) a first mixer for mixing concrete materials and water;

(ii) a second mixer for mixing concrete materials and water;

(iii) a first water container holding water that comprises carbonated concrete wash water;

(iv) a second water container, different from the first, holding water that is not carbonated concrete wash water; and

(iv) a first system fluidly connecting the first water container with the second mixer and a second system fluidly connecting the second water container with the first mixer.

~~22~~17. The apparatus of ~~claim 21~~claim 16 wherein the first and second mixers are different mixers.

~~23~~18. The apparatus of ~~claim 21 or 22~~claim 16 wherein the first mixer is the drum of a ready-mix truck.

~~24~~19. The apparatus of ~~any one of claims 21 to 23~~claim 16 further comprising a controller configured to add a first amount of the water in the second water container to the first mixer at a first time and to add a second amount of the water in the first water container to the second mixer at a second time, wherein the first and second times are different and wherein the first time is before the second time.

~~25~~20. An apparatus for preparing a concrete mix comprising

(i) a mixer for mixing concrete materials and water;

(ii) a first water container holding water that comprises carbonated concrete wash water;

(iii) a second water container, different from the first, holding water that is not carbonated concrete wash water; and

(iv) a third container, fluid connected to the first and second water containers and to the mixer, for receiving a first portion of the water in the first container and a second portion of the water in the second container, mixing them to form mixed waters, and sending a third portion of the mixed waters to the mixer.