It is claimed:

1. A method for monitoring and adjusting rheology and air content in a cementitious mix, comprising:

(a) providing a concrete mix in a concrete mixer, said concrete mix comprising hydratable cement, aggregates, and water for hydrating said cement, and said concrete mix having a total volume when mixed uniformly of 1.0 to 15.0 cubic yards;

(b) inputting into a computer processing unit (CPU) and storing into computer accessible memory desired concrete performance ranges relative to:

a rheology target or target range (hereinafter "R_T") wherein a desired concrete rheology or rheology range is specified within a range of 0 – 11 inches; and

an air content target or target range "A_T" wherein a desired concrete air content or air content range is within a range of 1% to 10%;

(c) operating said concrete mix in said concrete mixer drum and obtaining at least one rheology value in current time (hereinafter "R_{CT}") and at least one air content value in current time (hereinafter "A_{CT}");

(d) comparing using CPU said R_{CT} against said R_T and said A_{CT} against said A_T until detection by CPU of a non-conformance event, wherein said R_{CT} does not conform with said R_T and/or said A_{CT} does not conform with said A_T; and

(e) introducing into the concrete mix contained in said concrete mixer, one of at least two different types of additives comprising:

at least one chemical admixture for modifying air content in the concrete mix (hereinafter "ACA"), wherein said at least one ACA comprises at least one Air Entraining Admixture (hereinafter "AEA"), at least one Air Detraining Admixture ("ADA"), or mixture of at least one AEA and at least one ADA; and

at least one cement dispersant for modifying rheology of the concrete mix, said at least one cement dispersant comprising at least one polymeric dispersant, water, or a mixture of said at least one polymeric dispersant and water;

said introducing of said at least one ACA and/or at least one cement dispersant being achieved by CPU-controlled valve system in accordance with CPU-accessed memory device having at least four sets of data correlations: (i) effect of said cement dispersant on rheology; (ii) effect of said ACA on

air content; (iii) effect of said ACA on rheology; and (iv) effect of said cement dispersant on air content.

2. The method of claim 1 wherein said at least one ACA is an AEA.

3. The method of claim 1 wherein said at least one ACA is an ADA.

4. The method of claim 1 wherein said at least one ACA comprises an AEA and ADA.

5. The method of claim 1 wherein said at least one cement dispersant comprises a polycarboxylate polymer.

6. The method of claim 5 wherein said at least one ACA is an AEA.

7. The method of claim 1 wherein, in said Step (e), said at least four sets of correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value derived from at least two nominal dosage response curves.

8. The method of claim 7 wherein, in said Step (e), said at least four sets of data correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value derived from a plurality of nominal dosage response ("NDR") curves.

9. The method of claim 8, wherein in said NDR curves, said at least four sets of data correlations involves at least one non-homogeneous parameter selected from concrete mix design, concrete mix ingredient source, temperature, degree of hydration, water/cement ratio, and aggregate amount.

10. The method of claim 9 wherein in said NDR curves, said at least four sets of data correlations involves at least two non-homogeneous parameters selected from concrete mix design, concrete mix ingredient source, concrete temperature, degree of hydration, water/cement ratio, and aggregate amount.

11. The method of claim 1 wherein the changes in air content and rheology of the concrete mix as affected by doses of ACA and cement dispersant administered during a concrete mix delivery operation are incorporated into said nominal dose response (NDR) curves and scaling factors whereby said NDR curves and scaling factors (SF) are modified; and subsequent air and rheology changes in the same or a subsequent concrete mix delivery operation are effected based on said modified NDR curve or said modified SF.

12. The method of claim 11 wherein the CPU communicates wirelessly with CPU-accessible database memory having data relative to said changes in air content and rheology of concrete mixes as affected by doses of ACA and cement dispersant administered during concrete

mix delivery operation and incorporated into said nominal dose response (NDR) curves and scaling factors whereby said NDR curves and scaling factors (SF) are modified, as well as data relative to air and rheology changes in the same or a subsequent concrete mix delivery operations as effected based on said modified NDR curves or modified SF.

13. The method of claim 12 wherein the CPU-accessible database memory stores information on one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching for each data point relative to said changes in air content and rheology of concrete mixes as affected by doses of ACA and cement dispersant administered during concrete mix delivery operation.

14. The method of claim 13 where one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching are used to select the nominal dose response curve or scaling factor.

15. The method of claim 1 wherein said rheology characteristic is selected from slump, slump flow, and yield stress.

16. The method of claim 1 wherein said rheology characteristic is slump.

17. The method of claim 1 wherein said rheology characteristic is slump flow or DIN flow.

18. The method of claim 1 wherein said cement dispersant comprises water and a water reducing admixture.

19. The method of claim 18 wherein water is the cement dispersant added after ingredients are loaded into the mixing drum until reaching R_T and A_T, and water reducing admixture or superplasticizer is the cement dispersant used to maintain current rheology R_{CT} and current air content A_{CT} in the target ranges R_T and A_T.

20. The method of claim 1 wherein after step (e), concrete is mixed in a rotatable mixing drum a number of revolutions that is based on the identity of the cement dispersant and/or ACA added prior to discharging concrete or repeating step (c).

21. The method of claim 1 wherein steps (c) to (e) are repeated until the concrete is discharged from the mixer.

22. A mixing apparatus for monitoring and adjusting slump and air content in a cementitious mix, comprising:

(a) a concrete mixer drum for containing a concrete mix comprising

hydratable cement, aggregates, and water for hydrating said cement, the concrete mix having a total volume, when mixed uniformly within the concrete mixer drum, of 1.0 to 15.0 cubic yards;

(b) a computer processing unit and computer-processing unit-accessible memory, the computer processing unit programmed for inputting and storing into the computer processing unit-accessible memory concrete performance ranges relative to:

a target slump or target slump range; and

a target air content or target air content range wherein a concrete air content or air content range is within a range of 1% to 10%;

(c) the computer processing unit being further programmed for mixing a concrete mix contained in the concrete mixer drum and for obtaining at least one slump value in current time and at least one air content value in current time;

(d) the computer processing unit being further programmed for comparing the at least one slump value in current time against the slump target or slump target range and the at least one air content value in current time against the target air content or target air content range until detection of a non-conformance event, wherein the at least one slump value in current time does not conform with the target slump or target slump range and/or the at least one air content value in current time does not conform with the target air content or target air content range; and

(e) the computer processing unit being further programmed for introducing into the concrete mix contained in said concrete mixer drum, one of at least two compositionally different additives comprising:

at least one chemical admixture for modifying air content in the concrete mix, wherein the at least one chemical admixture for modifying air content in the concrete mix comprises at least one air entraining admixture, at least one air detraining admixture, or mixture of at least one air entraining admixture and at

least one air detraining admixture; and

at least one cement dispersant for modifying slump of the concrete mix, said at least one cement dispersant comprising at least one polymeric dispersant, water, or a mixture of said at least one polymeric dispersant and water;

the computer processing unit being further programmed for introducing of the at least one chemical admixture for modifying air content in the concrete mix and/or at least one cement dispersant being achieved by computer processor unit-controlled valve system in accordance with the computer processor unit-accessed memory, the aforementioned memory having at least four sets of data correlations comprising the effect of:

(i) the cement dispersant on slump of the concrete mix;

(ii) the at least one chemical admixture for modifying air content in the concrete mix on air content;

(iii) the at least one chemical admixture for modifying air content in the concrete mix on the slump of the concrete mix; and

(iv) the cement dispersant on air content of the concrete mix.

23. The mixing apparatus of claim 22 wherein

the at least one chemical admixture for modifying air content in the concrete mix is an air entraining agent.

24. The mixing apparatus of claim 22 wherein

the at least one chemical admixture for modifying air content in the concrete mix is an air detraining agent.

25. The mixing apparatus of claim 22 wherein

the at least one chemical admixture for modifying air content in the concrete mix comprises both an air entraining agent and an air detraining agent.

26. The mixing apparatus of claim 22 wherein

said at least one cement dispersant is a polycarboxylate polymer.

27. The mixing apparatus of claim 22 wherein

the four sets of correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value calculated from at least two nominal dosage response curves.

28. The mixing apparatus of claim 22 wherein

the four sets of correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value calculated from a plurality of nominal dosage response curves.

29. The mixing apparatus of claim 28 wherein,

in the nominal dosage response curves, the at least four sets of data correlations involve at least one non-homogeneous parameter selected from the group consisting of concrete mix design, concrete mix ingredient source, temperature, degree of hydration, water/cement ratio, and aggregate amount.

30. The mixing apparatus of claim 29 wherein,

in the nominal dosage response curves, the at least four sets of data correlations involve at least two non-homogeneous parameters selected from the group consisting of concrete mix design, concrete mix ingredient source, concrete temperature, degree of hydration, water/cement ratio, and aggregate amount.

31. The mixing apparatus of claim 22 wherein

the changes in air content and slump of the concrete mix as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during a concrete mix delivery operation are incorporated into the nominal dose response curves and scaling factors whereby the nominal dose response curves and scaling factors are modified; and subsequent air and slump changes in the same or a subsequent concrete mix delivery operation are effected based on the modified nominal dose response curves or the modified scaling factors.

32. The mixing apparatus of claim 31 wherein

the computer processor unit communicates wirelessly with computer processor unit –accessible database memory having data relative to the changes in air content and slump of concrete mixes as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during concrete mix delivery operation and incorporated into the nominal dose response curves and scaling factors whereby the nominal dose response curves and scaling factors are modified, as well as data relative to air and slump changes in the same or a subsequent concrete mix delivery operations as effected based on the modified nominal dose response curves or modified scaling factors.

33. The mixing apparatus of claim 32 wherein

the computer processor unit-accessible database memory stores information on one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching for each data point relative to the changes in air content and slump of concrete mixes as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during concrete mix delivery operation.

34. The mixing apparatus of claim 33 where one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching are used to select the nominal dose response curve or scaling factor.

35. The mixing apparatus of claim 22 wherein

the cement dispersant comprises water and a water reducing admixture.

36. The mixing apparatus of claim 35 wherein

water is the cement dispersant added after ingredients are loaded into the mixing drum until reaching the target slump or target slump range and the target air content or target air content range, and water reducing admixture or superplasticizer is the cement dispersant used to maintain the at least one slump value in current time and the at least

one air content value in current time in the target slump or target slump range and target air content or target air content range.

37. The mixing apparatus of claim 22 wherein

the computer processing unit is further programmed, after adding additive into the concrete mix, to rotate the mixing drum containing the concrete mix a number of revolutions that is based on the identity of the cement dispersant and/or the chemical admixture for modifying air content in the concrete mix added prior to discharging the concrete mix or resuming monitoring of the concrete slump.

38. The mixing apparatus of claim 22 wherein

the computer processing unit is programmed to repeat the following steps until the concrete is discharged from the mixer:

mixing a concrete mix contained in the concrete mixer drum and for obtaining at least one slump value in current time and at least one air content value in current time;

comparing the at least one slump value in current time against the slump target or slump target range and the at least one air content value in current time against the target air content or target air content range until detection of a non-conformance event, wherein the at least one slump value in current time does not conform with the target slump or target slump range and/or the at least one air content value in current time does not conform with the target air content or target air content range; and

introducing into the concrete mix contained in the concrete mixer drum, one of at least two compositionally different additives comprising:

at least one chemical admixture for modifying air content in the concrete mix, wherein the at least one chemical admixture for modifying air content in the concrete mix comprises at least one air entraining admixture, at least one air detraining admixture, or mixture of at least one air entraining admixture and at least one air detraining admixture; and

at least one cement dispersant for modifying slump of the concrete mix,

said at least one cement dispersant comprising at least one polymeric dispersant, water, or a mixture of said at least one polymeric dispersant and water; and

introducing the at least one chemical admixture for modifying air content in the concrete mix and/or at least one cement dispersant being achieved by computer processor unit-controlled valve system in accordance with the computer processor unit accessed memory, the aforementioned memory having at least four sets of data correlations comprising the effect of:

(i) the cement dispersant on slump of the concrete mix;

(ii) the at least one chemical admixture for modifying air content in the concrete mix on air content;

(iii) the at least one chemical admixture for modifying air content in the concrete mix on the slump of the concrete mix; and

(iv) the cement dispersant on air content of the concrete mix.

It is claimed:

1. A mixing apparatus for monitoring and adjusting slump and air content in a cementitious mix, comprising:

(a) a concrete mixer drum for containing a concrete mix comprising hydratable cement, aggregates, and water for hydrating said cement, the concrete mix having a total volume, when mixed uniformly within the concrete mixer drum, of 1.0 to 15.0 cubic yards;

(b) a computer processing unit and computer-processing unit-accessible memory, the computer processing unit programmed for inputting and storing into the computer processing unit-accessible memory concrete performance ranges relative to:

a target slump or target slump range; and

a target air content or target air content range wherein a concrete air content or air content range is within a range of 1% to 10%;

(c) the computer processing unit being further programmed for mixing a concrete mix contained in the concrete mixer drum and for obtaining at least one slump value in current time and at least one air content value in current time;

(d) the computer processing unit being further programmed for comparing the at least one slump value in current time against the slump target or slump target range and the at least one air content value in current time against the target air content or target air content range until detection of a non-conformance event, wherein the at least one slump value in current time does not conform with the target slump or target slump range and/or the at least one air content value in current time does not conform with the target air content or target air content range; and

(e) the computer processing unit being further programmed for introducing into the concrete mix contained in said concrete mixer drum, one of at least two compositionally different additives comprising:

at least one chemical admixture for modifying air content in the concrete mix, wherein the at least one chemical admixture for modifying air content in the concrete mix comprises at least one air entraining admixture, at least one air detraining admixture, or mixture of at least one air entraining admixture and at least one air detraining admixture; and

at least one cement dispersant for modifying slump of the concrete mix, said at least one cement dispersant comprising at least one polymeric dispersant, water, or a mixture of said at least one polymeric dispersant and water;

the computer processing unit being further programmed for introducing of the at least one chemical admixture for modifying air content in the concrete mix and/or at least one cement dispersant being achieved by computer processor unit-controlled valve system in accordance with the computer processor unit-accessed memory, the aforementioned memory having at least four sets of data correlations comprising the effect of:

(i) the cement dispersant on slump of the concrete mix;

(ii) the at least one chemical admixture for modifying air content in the concrete mix on air content;

(iii) the at least one chemical admixture for modifying air content in the concrete mix on the slump of the concrete mix; and

(iv) the cement dispersant on air content of the concrete mix.

2. The mixing apparatus of claim **1** wherein the at least one chemical admixture for modifying air content in the concrete mix is an air entraining agent.

3. The mixing apparatus of claim **1** wherein the at least one chemical admixture for modifying air content in the concrete mix is an air detraining agent.

4. The mixing apparatus of claim **1** wherein the at least one chemical admixture for modifying air content in the concrete mix comprises both an air entraining agent and an air detraining agent.

5. The mixing apparatus of claim 1 wherein said at least one cement dispersant is a polycarboxylate polymer.

6. The mixing apparatus of claim 1 wherein the four sets of correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value calculated from at least two nominal dosage response curves.

7. The mixing apparatus of claim 1 wherein the four sets of correlations identified in (i), (ii), (iii), and (iv) are based on an average or mean value calculated from a plurality of nominal dosage response curves.

8. The mixing apparatus of claim 7 wherein, in the nominal dosage response curves, the at least four sets of data correlations involve at least one non-homogeneous parameter selected from the group consisting of concrete mix design, concrete mix ingredient source, temperature, degree of hydration, water/cement ratio, and aggregate amount.

9. The mixing apparatus of claim 8 wherein, in the nominal dosage response curves, the at least four sets of data correlations involve at least two non-homogeneous parameters selected from the group consisting of concrete mix design, concrete mix ingredient source, concrete temperature, degree of hydration, water/cement ratio, and aggregate amount.

10. The mixing apparatus of claim 1 wherein the changes in air content and slump of the concrete mix as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during a concrete mix delivery operation are incorporated into the nominal dose response curves and scaling factors whereby the nominal dose response curves and scaling factors are modified; and subsequent air and slump changes in the same or a subsequent concrete mix delivery operation are effected based on the modified nominal dose response curves or the modified scaling factors.

11. The mixing apparatus of claim 10 wherein the computer processor unit communicates wirelessly with computer processor unit-accessible database memory having data relative to the changes in air content and slump of concrete mixes as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during concrete mix delivery operation and incorporated into the nominal dose response curves and scaling factors whereby the nominal dose response curves and scaling factors are modified, as well as data relative to air and slump changes in the same or a subsequent concrete mix delivery operations as effected based on the modified nominal dose response curves or modified scaling factors.

12. The mixing apparatus of claim 11 wherein the computer processor unit-accessible database memory stores information on one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching for each data point relative to the changes in air content and slump of concrete mixes as affected by doses of chemical admixture for modifying air content in the concrete mix and cement dispersant administered during concrete mix delivery operation.

13. The mixing apparatus of claim 12 where one or more of concrete mix design, concrete mix ingredient source, concrete temperature, water/cement ratio, and time since batching are used to select the nominal dose response curve or scaling factor.

14. The mixing apparatus of claim 1 wherein the cement dispersant comprises water and a water reducing admixture.

15. The mixing apparatus of claim 14 wherein water is the cement dispersant added after ingredients are loaded into the mixing drum until reaching the target slump or target slump range and the target air content or target air content range, and water reducing admixture or superplasticizer is the cement dispersant used to maintain the at least one slump value in current time and the at least one air content value in current time in the target slump or target slump range and target air content or target air content range.

16. The mixing apparatus of claim 1 wherein the computer processing unit is further programmed, after adding additive into the concrete mix, to rotate the mixing drum containing the concrete mix a number of revolutions that is based on the identity of the cement dispersant and/or the chemical admixture for modifying air content in the concrete mix added prior to discharging the concrete mix or resuming monitoring of the concrete slump.

17. The mixing apparatus of claim 1 wherein the computer processing unit is programmed to repeat the following steps until the concrete is discharged from the mixer:

mixing a concrete mix contained in the concrete mixer drum and for obtaining at least one slump value in current time and at least one air content value in current time;

comparing the at least one slump value in current time against the slump target or slump target range and the at least one air content value in current time against the target air content or target air content range until detection of a non-conformance event, wherein the at least one slump value in current time does not conform with the target slump or target slump range and/or the at least one air content value in current time does not conform with the target air content or target air content range; and

introducing into the concrete mix contained in the concrete mixer drum, one of at least two compositionally different additives comprising:

at least one chemical admixture for modifying air content in the concrete mix, wherein the at least one chemical admixture for modifying air content in the concrete mix comprises at least one air entraining admixture, at least one air detraining admixture, or mixture of at least one air entraining admixture and at least one air detraining admixture; and

at least one cement dispersant for modifying slump of the concrete mix, said at least one cement dispersant comprising at least one polymeric dispersant, water, or a mixture of said at least one polymeric dispersant and water; and

introducing the at least one chemical admixture for modifying air content in the concrete mix and/or at least one cement dispersant being achieved by computer processor unit-controlled valve system in accordance with the computer processor unit accessed memory, the aforementioned memory having at least four sets of data correlations comprising the effect of:

(i) the cement dispersant on slump of the concrete mix;

(ii) the at least one chemical admixture for modifying air content in the concrete mix on air content;

(iii) the at least one chemical admixture for modifying air content in the concrete mix on the slump of the concrete mix; and

(iv) the cement dispersant on air content of the concrete mix.