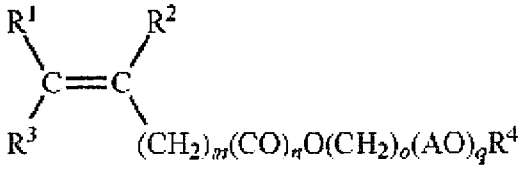
It is claimed:

1. A method for achieving low-to-mid-range water reduction in a hydratable cementitious composition, comprising:

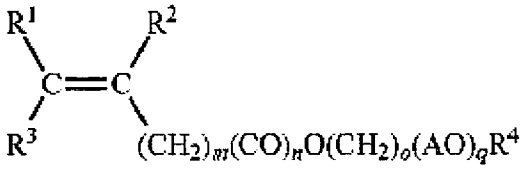
combining with water and cement to form a hydratable cementitious mixture, wherein the water-to-cement (w/c) ratio is at least 0.44 and no greater than 0.80, and further combining with the water and cement at least one comb-type carboxylate copolymer formed from the following monomer components (A), (B), (C), and optionally (D):

(A) a first polyoxyalkylene monomer represented by structural formula:



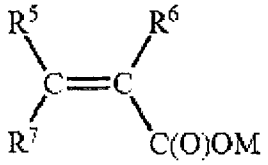
wherein R^1 and R^2 individually represent hydrogen atom or methyl group; R^3 represents hydrogen or —COOM group wherein M represents a hydrogen atom or an alkali metal; AO represents oxyalkylene group having 2 to 4 carbon atoms or mixtures thereof; "m" represents an integer of 0 to 2; "n" represents an integer of 0 or 1; "o" represents an integer of 0 to 4; "p" represents an average number of oxyalkylene groups and is an integer from 8-25; and R^4 represents a hydrogen atom or C_1 to C_4 alkyl group;

(B) a second polyoxyalkylene monomer represented by structural formula:



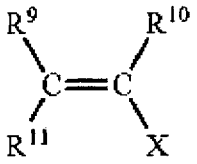
wherein R^1 and R^2 individually represent hydrogen atom or methyl group; R^3 represents hydrogen or —COOM group wherein M represents a hydrogen atom or an alkali metal; AO represents an oxyalkylene group having 2 to 4 carbon atoms or mixtures thereof; "m" represents an integer of 0 to 2; "n" represents an integer of 0 or 1; "o" represents an integer of 0 to 4; "q" represents an average number of oxyalkylene groups and is an integer from 20 to 100; and R^4 represents a hydrogen atom or C_1 to C_4 alkyl group;

(C) an unsaturated carboxylic acid monomer represented by structural formula:



wherein R^5 and R^6 individually represent hydrogen atom or methyl group; R^7 represents hydrogen atom, $C(O)OR^8$, or $C(O)NH\ R^8$ wherein R^8 represents a C_1 to C_4 alkyl group, and M represents a hydrogen atom or an alkali metal; and, optionally,

(D) an unsaturated, water-soluble monomer represented by structural formula:



wherein R^9, R^{10}, and R^{11} each independently represent a hydrogen atom, methyl group or C(O)OH; X represents $C(O)NH_2$, $C(O)NHR^{12}$, $C(O)NR^{13}R^{14}$, $O—R^{15}$, SO_3H, $C_6H_4SO_3H$, or $C(O)NHC(CH_3)_2CH_2SO_3H$, or mixture thereof, wherein R^{12}, R^{13}, R^{14}, and R^{15} each independently represent a C_1 to C_5 alkyl group; and

wherein the molar ratio of component (A) to component (B) is from 15:85 to 85:15, and further wherein the molar ratio of component (C) to the sum of component (A) and component (B) is 90:10 to 50:50;

wherein the difference between "q" in said second polyoxyalkylene monomer of component (8) and "p" in said first polyoxyalkylene monomer of component (A) is an integer of at least 8; and

where the water content of a concrete prepared by the method is reduced by less than 12 percent while attaining same slump compared to the concrete mixture not treated with the polymer.

2. The method of claim **1** wherein said hydratable cementitious mixture is a concrete having a cement to concrete ratio within the range of 240 to 340 kg/m^3.

3. The method of claim **1** wherein, in said first and second monomer components (A) and (B), the polyoxyalkylene is polyoxyethylene.

4. The method of claim **1** wherein "m", "n", and "o" in component (A) or component (B) are integers of 0, 1, and 0, respectively.

5. The method of claim **1** wherein, the sum of "p" in said first polyoxyalkylene monomer of component (A) and "q" in said second polyoxyalkylene monomer of component (B) is no more than 120.

6. The method of claim **5** wherein the sum of "p" in said first polyoxyalkylene monomer of component (A) and "q" in said second polyoxyalkylene monomer of component (B) is no more than 80.

7. The method of claim **1** wherein the molar ratio of component (A) to component (B) is from 20:80 to 75:25.

8. The method of claim **1** wherein the molar ratio of component (A) to component (B) is from 25:75 to 65:35.

9. The method of claim **1** wherein the molar ratio of component (C) to the sum of component (A) and component (B) is 80:20 to 60:40.

10. The method of claim 1 wherein the molar ratio of component (C) to the sum of component (A) and component (B) is 75:25 to 65:35.

11. The method of claim 1 wherein said at least one carboxylate copolymer further comprises constituent groups derived from polymerization using component (D) monomer, and the molar ratio of constituent groups derived from component (D) to the sum of constituent groups derived from component (A), component (B), and component (C) is 1:99 to 20:80.

12. The method of claim **1** wherein said at least one comb-type carboxylate copolymer has a weight-average molecular weight of 10,000-40,000.

13. The method of claim **1** wherein said at least one comb-type carboxylate copolymer has a weight-average molecular weight of 12,000-30,000.

14. The method of claim **1** wherein the weight ratio of water to cement is larger than 0.51.

15. The method of claim **1** wherein the active amount of said comb-type carboxylate copolymer is from 0.04 to 0.14% by weight of cement.

16. The method of claim 15, wherein the active amount of said comb-type carboxylate copolymer is from 0.05 to 0.11% by weight of cement.

17. The method of claim 1 further comprising adding to the cement and water at least one admixture chosen from gluconic acid or salt thereof, an alkanolamine, an air detraining agent, an air-entraining agent, and mixtures thereof.

18. The method of claim 17 wherein said at least one admixture is chosen from gluconic acid or salt thereof is mixed with said carboxylate copolymer prior to combining with said cement and water.

19. The method of claim 1 wherein said at least one comb-type carboxylate copolymer consists essentially of constituents formed from using only monomer components (A), (B), and (C).

20. A cementitious composition made by the method of claim 1.