TECHNICAL NOTES

USDA-Natural Resources Conservation Service
Boise, Idaho

TN ENGINEERING NO. 11 January 24, 2000

CONCRETE ADMIXTURES

This technical note provides a discussion on some of the more common concrete admixtures that are used in concrete applicable to conservation practices.

This note provides information on the following five categories of admixtures:

1. Air-entraining Agents
2. Water-reducing Agents and High Range Water Reducers (Superplasticizers)
3. Retarding Agents
4. Pozzolans
5. Accelerators

The NRCS-Idaho Construction Specifications require the use of some admixtures such as air-entrainment, permit the use of others such as pozzolans and water-reducing agents and prohibit the use of others such as calcium chloride.

AIR-ENTRAINING AGENTS

Air-entrainment agents introduce tiny air bubbles into the concrete mix. They are used in concrete primarily to improve weathering resistance to freezing and thawing. The proper amount of air in a concrete mortar will increase this resistance about 10 times. Air-entrainment also increases workability, increases cohesiveness and reduces segregation and bleeding. The smaller the aggregates in a mixture the more air-entrainment that is required to provide the same degree of resistance to freezing and thawing. The recommended percentage of air by volume in concrete is:

Aggregate Size (Inch)	Percent by Volume
3	3.5 +/- 1
1.5 to 2.5	5.0 +/- 1
3/4	6.0 +/- 1
3/8	7.5 +/- 1

There are a number of commercially available air-entrainment products. Most of the air-entraining admixtures are supplied in ready to use liquid form. These products are commonly

applied to the concrete mix when it is being batched. All concrete used in the NRCS-Idaho conservation programs will have air-entrainment. Products used shall meet the requirements of ASTM C 260 “Air-Entraining Admixtures for Concrete” and generally meet the percentages shown above.

WATER-REDUCING AGENTS AND HIGH RANGE WATER REDUCERS (SUPERPLASTICIZERS)

Water-reducing agents are chemical additives that reduce the quantity of mixing water required to produce concrete of a given consistency. Water-reducing admixtures that reduce the water required for mixing by 12 percent or greater are classified as high-range water-reducing additives. These products are often referred to as superplasticizers.

In the Redi-Mix designs submitted for certification the use of a water-reducing agent that reduces the mixing water requirement by 5 to 10 percent is the most common. The use of superplasticizers requires close quality control and their use should be limited to larger structures where conditions warrant their cost. Superplasticizers will typically cost about $10/cu yd of concrete.

A reduction of water in a concrete mix results in higher concrete strength, increases resistance of concrete to sulfate attack and decreases the permeability of the concrete. Workability can be decreased and may be an issue in getting concrete properly placed around corners and tightly spaced reinforcement. These admixtures shall meet the requirements of ASTM C 494 “Chemical Admixtures for Concrete” or C 1017 “Chemical Admixtures for Use in Producing Flowing Concrete”.

SET-RETARDING AGENTS

Set-retarding admixtures are chemical additives that retard or slow down the setting of concrete. These admixtures allow additional time between mixing and the final placement of the concrete. Due to the long distances from concrete batch plants to many field sites, set-retarding agents are used in site specific concrete designs. These admixtures shall meet the requirements of ASTM C 494 “Chemical Admixtures for Concrete”.

WATER-REDUCING AND RETARDING ADMIXTURE

Water-reducing and retarding admixtures are chemical additives that provide for both a reduction in mixing water and also slows or delays the setting of the concrete. These admixtures shall meet the requirements of ASTM C 494 “Chemical Admixtures for Concrete”.

POZZOLANS

Pozzolans are siliceous and aluminous materials, which in themselves possess little or no cementitious properties, but will chemically react with the calcium hydroxide in Portland Cement at ordinary temperatures to form compounds possessing cementitious properties. Pozzolans can be classified petrographically as follows:

1. Calcined clays and shales.
2. Opaline materials such as diatomaceous earth and opaline cherts and shales.
3. Volcanic tuffs and pumicites of rhyolitic, phonolitic or andisitic composition.
4. Industrial by-products such as fly ash, ground brick or silica fume.

Except for rare occurrences, natural pozzolans must be ground before use. The clayey materials including alterated volcanic ash and tuffs as well as shales must be calcined at temperatures between 1200 degrees and 1800 degrees.

Pozzolans are not normally required in our construction specifications. However a few Redi-Mix suppliers have mixes that commonly include fly-ash as a substitute for a portion of the cement. The NRCS-Idaho Construction Specifications allow up to a 20 percent substitution of fly-ash for cement. Because pozzolan properties vary greatly, a cylinder test break should be required to determine how the pozzolan reacts with the cement and aggregate to be used before accepting pozzolan into a design mix.

Advantages of using pozzolans include improved workability of the concrete, reduced heat of hydration, reduced thermal column change, reduced bleeding and lower permeability of the concrete. Some pozzolans control or reduce the alkali-aggregate reaction where reactive aggregates and high-alkali cement are used.

Disadvantages include reduced resistance to freezing and thawing until the concrete is thoroughly cured, possible excessive drying and shrinking of concrete, reduced concrete strength and lower durability.

Pozzolans should be used with caution. Their properties may vary widely and some may add adverse qualities into the concrete. Before accepting the use of pozzolans other than fly ash in a concrete design you should evaluate the advantages/disadvantages for the proposed structure. Concrete cylinder test breaks need to be supplied by the concrete supplier using the cement and aggregate for the site specific concrete mix prior to acceptance. Pozzolans shall conform to the requirements of either ASTM C 618, “Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete” or C 989, Ground Grandulated Blast-Furnace Slag for Use in Concrete and Mortars”.

ACCELERATING AGENTS

Accelerators are chemical additives, which decreases the time for the setting of the concrete. Accelerators can be used to increase early strength in concrete but they can cause a reduction in strength of the cured concrete and increased shrinkage of the concrete.

Calcium chloride is a commonly used accelerating admixture. Most requests are from contractors wanting to use calcium chloride in lieu of properly heating and curing concrete under cold-weather conditions. However, calcium chloride is not an anti-freeze for concrete and it does not materially lower the freezing point of concrete. Calcium chloride can also cause corrosion of reinforcement steel.

The use of accelerators is not allowed in the NRCS-Idaho construction specifications or the NEH-20, Concrete Construction Specifications.

The use of Type III, high early strength cement is recommended when early concrete strength is desired or needed.

REFERENCES

- ACI 301, Field Reference Manual, Publication SP-15-89
- Concrete Manual, 8th Edition, USDI, Bureau of Reclamation

Prepared by G. Arthur Shoemaker, State Conservation Engineer, January 2000.

File this in the Engineering section of the Technical Notes, Section VI of the Technical Guide.