CONCRETE ADMIXTURES CLASSIFICATION

1. Air-entraining admixtures
2. Water-reducing admixtures
3. Retarding admixtures
4. Accelerating admixtures
5. Superplasticizers
6. Finely divided mineral admixtures
7. Miscellaneous admixtures such as workability, bonding, dampproofing, permeability-reducing, grouting, gas-forming, coloring, corrosion inhibiting, and pumping admixtures

Chemical Admixtures

- **Type A: Water-reducing (WR)**
- **Type B: Set retarding (SR)**
- **Type C: Set accelerating (SA)**
- **Type D: WR + SR**
- **Type E: WR + SA**
- **Type F: High-range water-reducing (HRWR)**
- **Type G: HRWR + SR**

Mineral Admixtures

- Raw or calcined pozzolans
- Fly ash produced from burning bituminous coal
- Fly ash normally produced from burning lignite (subbituminous) coal. (both pozzolanic and cementatious).

Air Entraining Admixtures

Air entrainment refers to the introduction of large quantities of tiny air bubbles in the concrete matrix. The main reason for air entrainment is to improve the durability of the concrete to freeze-thaw degradation.

The Air-Void System

As un-reacted water freezes it expands 9 % by volume on phase change. This internal volume expansion causes internal stresses in the matrix. It can generate cracks in the concrete, which may allow water to infiltrate and the process can get progressively worse. It can lead to significant degradation of the concrete.

The formation of ice in the pore spaces generates pressure on any remaining unfrozen water. Introducing a large quantity of air bubbles provides a place for this water to move in to relieving the internal pressure. What is desired is to generate very many small air bubbles well distributed throughout the matrix rather than a smaller number of larger bubbles.

It's been determined that the optimum air content for frost protection is about 9% by volume of the mortar fraction. With respect to the concrete volume, the air content should

be in the range of 4-8% by volume. The concrete normally has entrained air, the admixture increases the total volume of the air voids by 3-4% of the concrete volume.

Total air content is only a part of the formula for frost resistance. The nature of the entrained air is equally important. The critical parameter of the air-entrained paste is the spacing factor (max distance from any point in the paste to the edge of a void). It should not exceed 0.2 mm; the smaller the spacing factor the more durable the concrete.

The air bubbles themselves should be in the range of 0.05 – 1.25 mm in diameter.

Air Entraining Materials

What is needed is an agent that causes the water to foam into a very small matrix of very small bubbles. The admixtures are of the same family as household detergents, but these do not generate small enough bubbles and are not stable enough.

Air entraining agents contain surface-active agents or surfactants. These lower the water surface tension so bubbles can form, and stabilize the bubbles once they are formed.

Increasing the admixture dosage will increase air content, decrease bubble size, and decrease spacing factor. Thus decreasing the total strength of the concrete.

Effect of Air on Other Concrete Properties

- **Increase workability and cohesiveness of fresh concrete.**
- **Considerable reduction in bleeding and segregation.**
- **Decreased strength (10-20% for most air entrained concrete)**
- **Increased durability (up to ~7% air; SEE FIG 7.6 Mindess)**

- **If a lower *w/c* ratio is used to account for the increased slump, some of the strength reduction will be offset.**
- **In addition, the lower w/c ratio that can be used and the better compaction**
- **characteristics results in more impermeable concrete and a better overall resistance to**
- **aggressive agents (i.e. sulfates).**

Chemical Admixtures

Water-Reducing Admixtures

These admixtures **lower the water required to attain a given slump**, thus lowering the *w/c* ratio. This will:

- Improve the strength
- Improve the water tightness
- Improve durability.

Alternately it may be used to maintain the same *w/c* ratio but increase workability for difficult placement.

Typical reductions in water requirements are 5-10%

There are admixtures called **"superplasticizers" or "high-range water reducers"** which can reduce water contents by 15-30%.

The water reducers reduce the electronegative charges on the fine cement particles allowing them to disperse more readily in the water. (Similar to the use of Calgon in hydrometer tests). This reduces the tendency for flocculation of the cement particles in the paste.

Composition

Three General Categories

1. salts and derivatives of lignosulfonates.

2. salts and derivatives of hydroxycarboxylic acids.
3. polymeric materials.