Admixtures for Concrete
Admixtures

- Air-entraining admixtures
- Water-reducing admixtures
- Plasticizers
- Accelerating admixtures
- Retarding admixtures
- Hydration-control admixtures
- Corrosion inhibitors
- Shrinkage reducers
- ASR inhibitors
- Coloring admixtures
- Miscellaneous admixtures
Air-Entraining Admixtures

ASTM C 260 or AASHTO M 154

- Improve durability in concrete exposed to
  - Freeze-thaw
  - Deicers
  - Sulfates
  - Alkali-reactive environments
- Improve workability
Frost Damage

Admixtures for Concrete
Scaled Concrete Surface
Water-Reducing Admixtures

Primarily used to:

- Reduce mixing water required to produce a certain slump
- Reduce water-cement ratio
- Reduce cement content
- Increase slump
Water Reducing Admixtures

ASTM C 494 or AASHTO M 194

~ Type A —
  ~ reduces water content at least 5%
  ~ tends to retard — accelerator often added

~ Type D —
  ~ reduces water content 5% min.
  ~ retards set

~ Type E —
  ~ reduces water content 5% min.
  ~ accelerates set
Water Reducer and Slump Loss

![Graph showing the slump loss over elapsed time for different admixtures.](image)
Admixtures for Concrete

Retardation (Initial Set)

![Chart showing retardation hours for different admixtures with Cement 1 and Cement 2.]

- L: Cement 1 (1.5 hours), Cement 2 (1.0 hour)
- H: Cement 1 (2.5 hours), Cement 2 (1.5 hours)
- N: Cement 1 (1.8 hours), Cement 2 (1.2 hours)
- M: Cement 1 (3.0 hours), Cement 2 (3.5 hours)
- B: Cement 1 (0.8 hours), Cement 2 (0.8 hours)
- X: Cement 1 (1.4 hours), Cement 2 (1.4 hours)
Retardation (Final Set)

- Admixtures for Concrete

<table>
<thead>
<tr>
<th>Admixture</th>
<th>Retardation, hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>1</td>
</tr>
<tr>
<td>H</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>X</td>
<td>2</td>
</tr>
</tbody>
</table>

Legend:
- Blue: Cement 1
- Yellow: Cement 2
Mid-Range Water Reducing Admixtures

- Reduce water content 6% to 12%
- Reduce cement content
- Reduce water-cement ratio
- No retardation
- Improve placeability and finishability
Admixtures for Concrete
High-Range Water-Reducing Admixtures

ASTM C 494 or AASHTO M 194

Type F — Water Reducing

Type G — Water Reducing and Retarding

- Reduce H₂O content 12% - 30%
- Reduced W/C produces conc. with:
  - Compressive Strength > 70 MPa
  - Increased early strength gain
  - Reduced Cl⁻ ion penetration
Admixtures for Concrete

High-Range Water Reducer and Slump Loss

[Graph showing the effect of elapsed time on slump, with different admixtures represented by different symbols and colors.]
# HRWR, Water Reducer and Air Loss

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Initial air content, %</th>
<th>Final air content, % *</th>
<th>Percent air retained</th>
<th>Rate of air loss, %/minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>C</td>
<td>5.4</td>
<td>3.0</td>
<td>56</td>
</tr>
<tr>
<td>Water reducer</td>
<td>L</td>
<td>7.0</td>
<td>4.7</td>
<td>67</td>
</tr>
<tr>
<td>High-range water reducer</td>
<td>N</td>
<td>6.8</td>
<td>4.8</td>
<td>71</td>
</tr>
<tr>
<td>High-range water reducer</td>
<td>M</td>
<td>6.4</td>
<td>3.8</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>6.8</td>
<td>5.6</td>
<td>82</td>
</tr>
</tbody>
</table>

*at point where slump falls below 25 mm
Compressive Strength Development

**Graph:**
- **Y-axis:** Compressive strength, MPa
- **X-axis:** Age, days
- **Legend:**
  - C
  - N
  - M
  - X

**Description:**
- The graph illustrates the development of compressive strength over time for different concrete admixtures.
- Each line represents a different admixture type, showing how strength increases with age.
- The legend identifies the types of admixtures represented by different symbols and colors.
Admixtures for Concrete

Plasticizers for Flowing Concrete

Also known as —

Superplasticizers

ASTM C 1017

Type 1 — Plasticizing
Type 2 — Plasticizing and Retarding

- Essentially High-Range Water Reducer
Plasticizers for Flowing Concrete

Superplasticizers

ASTM C 1017

- Produce flowing concrete with high slump ($\geq 190$ mm [7.5 in.])
- Reduce bleeding
- Extended-slump-life plasticizer reduces slump loss.
Flowing Concrete as Thin Overlay
Flowing Concretes and Slump Loss

![Graph showing slump loss over time for different admixtures: TC, TN, TM, TB, TX.](image-url)
Admixtures for Concrete

Retardation of Flowing Concrete (Initial Set)

- N
- M
- B
- X

Retardation, hours

Cement 1
Cement 2

Admixture
Retardation of Flowing Concrete (Final Set)

- Admixtures for Concrete

![Bar Chart]

- Retardation, hours
- Admixture: N, M, B, X
- Cement 1: Blue bars
- Cement 2: Yellow bars
Compressive Strength Development in Flowing Concrete

![Graph showing compressive strength development over time for different admixtures.](image)
Admixtures for Concrete

Bleeding of Flowing Concrete

![Bar chart showing bleeding percentage for different admixtures: C (minimum), N, M, B, X (maximum)]
Retarding Admixtures

ASTM C 494 or AASHTO M 194, Type B

Delay setting or hardening rate for:

- Hot-weather concreting
- Difficult placements
- Special finishing processes
Slump Loss at Various Temperatures

![Graph showing slump loss at various temperatures. The graph compares slump loss for different admixtures and temperatures.](image)
Accelerating Admixtures

ASTM C 494 or AASHTO M 194, Type C

Accelerate the rate of:
- Hydration (setting)
- Early-age strength gain

Calcium chloride accelerators:
- Increase drying shrinkage,
  potential reinforcement corrosion,
  potential scaling
- Darken concrete
### Maximum Chloride-Ion Content

<table>
<thead>
<tr>
<th>Type of member</th>
<th>Maximum water soluble chloride-ion ($\text{Cl}^-$) in concrete, percent by mass of cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prestressed concrete</td>
<td>0.06</td>
</tr>
<tr>
<td>Reinforced concrete exposed to chloride in service</td>
<td>0.15</td>
</tr>
<tr>
<td>Reinforced concrete that will be dry or protected from moisture in service</td>
<td>1.00</td>
</tr>
<tr>
<td>Other reinforced concrete construction</td>
<td>0.30</td>
</tr>
</tbody>
</table>
Corrosion Inhibitors

- Control Corrosion of Steel Reinforcement
- Dosage dependent on anticipated chloride level
Shrinkage-Reducing Admixtures
ASR Inhibitors—Lithium Carbonate

$Li_2CO_3$ dosage (% by mass of cement)

- None
- 0.25
- 0.50
- 1.00

ASTM C 227
Coloring Admixtures (Pigments)
Liquid Admixture Dispenser

Admixtures for Concrete
Admixtures for Concrete

Air-Entraining Admixture

Water Reducer

Videos 1/2
Admixtures for Concrete

Videos 2/2

Retarder/Accelerator

Admixture Dispenser