Innovations in Chemical Admixture Technology as Related to Sustainability, Part 2

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Outlines
- Sustainable concrete
- Materials for chemical admixtures
- Combinations of Lignosulfonates and Polycarboxylate Ethers
- Experimental work
- Results and discussions
- Conclusions
- Path forward

Concrete
- Combination of
- Organic (Synthetic) and
- Natural ingredients
- Cast and Cured with / without
- Reinforcement in the
- Environment using
- Technology and
- Effective human resources

Sustainable Concrete
HOW TO

- SUSTAINABLE CONCRETE
  - Optimization of materials
  - Recycling and waste management
  - Improvement and optimization of structures
  - Innovation in materials and processes

ROLE OF CONCRETE ADMIXTURES

- CONCRETE ADMIXTURES
  - Reduced cement
  - Reduced CO₂ emission
  - Reduced W : B ratio
  - Increased workability retention
  - Increased compressive strength
  - Reduces rejections / repairs
  - Reduces element mass

MATERIALS

LIGNOSULFONATES (LS)
- Green and sustainable chemical
- Carbon content of LS is 400 gm. / kg.
- 1.5 kg of CO₂ is withdrawn from atmosphere/kg of LS
- Steric + Electrostatic repulsion.
- Excellent compatibility with SNF, SMF and PCEs.
- Most grades are compatible with Alternative Cementitious Materials.

SULFONATED NAPTHALENE FORMALDEHYDE (SNF)
- Made using Napthelene, Formaldehyde and H₂SO₄.
- Works well for concretes up to 60 MPa.
- Better initial slump than LS.
- Compatible with most retarders and LS
- Long retention of slump is possible.
- Generally not compatible with PCEs.

POLYCARBOXYLATE ETHERS (PCE)
- Excellent dispersion helps high strengths
- Steric repulsion results in good water reduction at very low dosages.
- SCC can be made most of the times, without the use of VMAs
- Opens opportunities to obtain results with variety of cement types and ACMs.
- Dosage is very sensitive.
- Compatibility with retarders and defoamers is critical.
COMBINATIONS OF LIGNOSULFONATE AND PCE’s

ASPECTS
- Synergy
- Cost
- Versatility
- Foaming tendency
- Compatibility
- Workability
- Strength development
- Cement compatibility

SCOPE
- Study Ca-LS and Na-LS combinations with PC-WR. The results are compared with SNF : LS combinations
- Na-LS from 2 different sources, PCE’s from 3 different sources and Ca-LS from single source
- Concrete trials at two different dosages

EXPERIMENTAL WORK

CONCRETE PROPORTIONS

<table>
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<th>Material</th>
<th>Material Type</th>
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<th>Moist</th>
<th>W.A.</th>
<th>SSD</th>
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<td>Cementitious</td>
<td>UltraTech OPC 33</td>
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<td>Fly Ash</td>
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<td>Water / Cement Ratio =</td>
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COMBINED GRADATION
SETTING TIMES AT 0.7% DOSAGE

WORKABILITY AT 0.7 % DOSAGE

COMPRESSIVE STRENGTHS AT 0.7% DOSAGE

SETTING TIMES AT 0.9 % DOSAGES

WORKABILITY AT 0.9% DOSAGE

COMPRESSIVE STRENGTHS AT 0.9 % DOSAGE
COMPATIBILITY, SETTING TIME AND WORKABILITY

- Compatibility of PC-WR and LS combinations has been established.
- At 25°C, all formulations at 0.7 and 0.9 % dosages are near to the requirement of ASTM C-494 type G, for setting time.
- As the dosage is low retardation is under control.
- At 0.7% PC-WR : PC-SR and their combination, gives good workability retention.
- 50 : 50 combinations of PC-WR and NAL’s give good initial workability but the slump drops quickly after 30 minutes.

COMPRESSIVE STRENGTH AND AIR CONTENT

- Best compressive strength achieved @ 0.7% dosage.
- Compressive strengths
  - At 0.7% dosage
    - Pure PCE’s > 75:25 PCE : LS > 50:50 PCE : LS.
  - At 0.9% dosage
    - 75:25 PCE : Na-LS > 50:50 PCE : Na-LS
- Air content of all the mixes has not varied much due to lower dosages.
CONCLUSIONS

- Combinations of PCEs with LS will add a significant value to concrete sustainability.
- LS has good compatibility, with all the PCE molecules used in this study.
- PCE : LS combination are most desirable where SNF:LS combinations fail or require higher dosages.
- The synergy of PCE: LS combinations, have opened up an excellent option for Admixture formulators.
- Good workability retention and comparatively higher strengths achieved, suggest that significant cost and material savings may be obtained, using PCE : LS combinations.

PATH FORWARD

- Work in Progress
  - Study involving GGBFS and different cement brands.
  - To check other PCE molecules.
- Further Studies
  - Long term compatibility and compatibility with various cement types.
  - At higher dosages and higher W/B ratios.

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THANK YOU

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