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Shrinkage-Compensating Concrete—Past, Present, and Future, Part 1

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Experiences on the use of component G in Mexico

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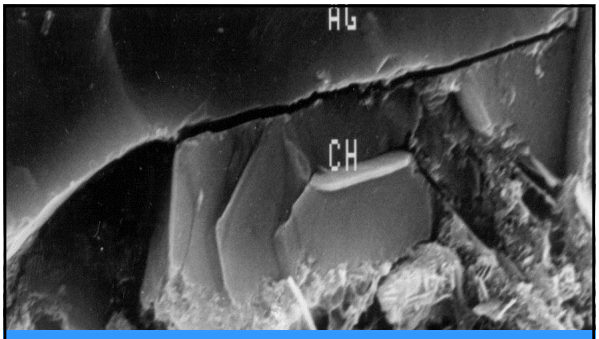
- Component G
- Industrial floor durable solution through Shrinkage Compensated Concrete
- Mexico City Metropolitan area elevated deck highway considering shrinkage control concrete



Expansion mechanism

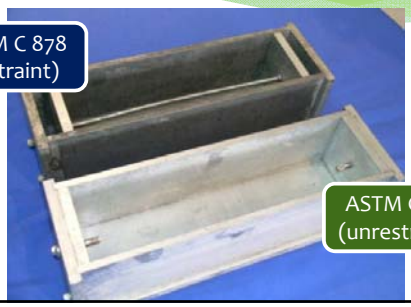
Component G

Expansion mechanism for shrinkage control in concrete

- Ettringite formation
  - Expansive cements K, M and S
  - Component K : Calcium Sulphoaluminate component
- Portlandite formation
  - Component G: Calcium Oxyde

Availability in Mexico: Component G and Component K

Length change



Length change

Accurate readings since the specimen cast

Concrete mix design considerations for shrinkage control

- Typical low shrinkage mix design:
  - w/cm ratio
  - Aggregate top size
  - Paste volume (Cementitious and water amounts)
  - Joint spacing design
- Regional aggregate influence
- Regional cementitious composition influence
- Expansive component quality control
- Weather influence on service life

Concrete mix materials

- Cement
  - Composed cements and fineness
    - Prone to shrink more?
    - Local testing to select the cement that produces the less shrinkage possible
  - International recommendations to be adjusted according to local job conditions

Concrete mix materials

- Aggregate
  - Nature fine particles can produce a strong influence on shrinkage
  - Maximum aggregate size 25 or 38 mm, dense, with less than 1% of contaminants and specific gravity >2,5 g/cm^3
  - Continuous grading
  - Maximum coarse/fine aggregate ratio (~60/40)

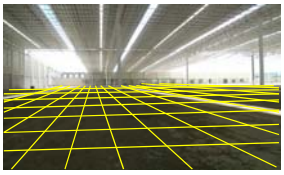
Concrete mix materials

- Admixtures and additions
  - Water reducing (ASTM C 494 Type D)
  - Superplasticizers (ASTM C 1017 Type I)
  - Air detrainer
    - Less than 3%
  - Cement stabilizer
  - Expansive component G

Distribution Center requirements

- Project: 54 000 m²
- Slab thickness = 15 cm
- Mechanical properties:
  - Compressive strength 28 MPa at 28 days
- Jointless floor surface from 1045 to 1567 m²

Joint spacing benefits through Shrinkage Compensated Concrete



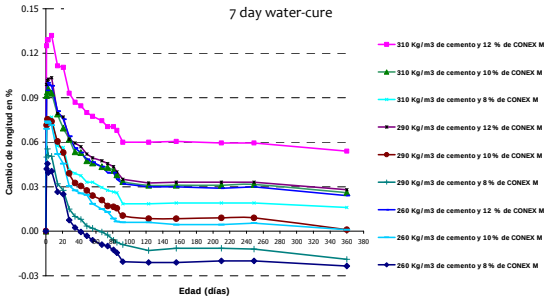
Distribution Center mix design

- Mexican Cement Type CPO 30 RS BRA BCH
- Maximum aggregate size: 38 mm
- Less than 180 L/m³ of water
- Slump: 12 cm
  - Keep workability for more 60 min (use of superplastizicers)
- Air content: 1.7 to 2.2 %
- Initial set time: 6 to 7 hours
- Length change ASTM C 878:
  - Quality control for delivery: 700 µm at 24 hours
- Finish operations similar to conventional industrial floors

SSD Mix design per m³

Cement CPC 40	310	kg
Coarse agg 5-40 mm (Basalt)	1094	kg
River sand	744	kg
Water	170	L
HRWR Eucon 37	2.2	L
Component G Conex M	29	kg

ASTM C 878 Length change



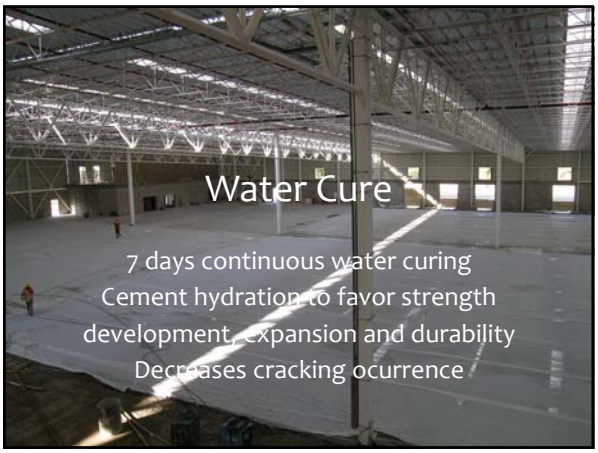
Induced crack control

Set time

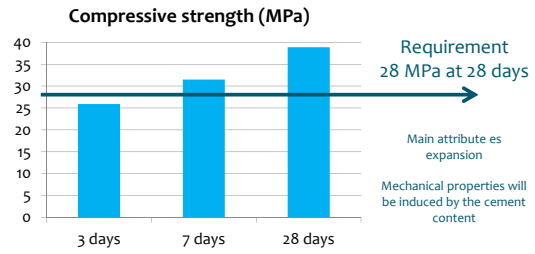
Initial 7:06 hours

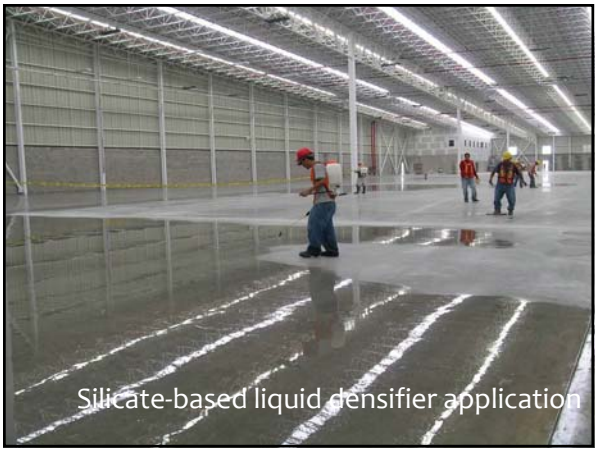
Final 8:36 hours

Lab conditions (23 ± 2°C)



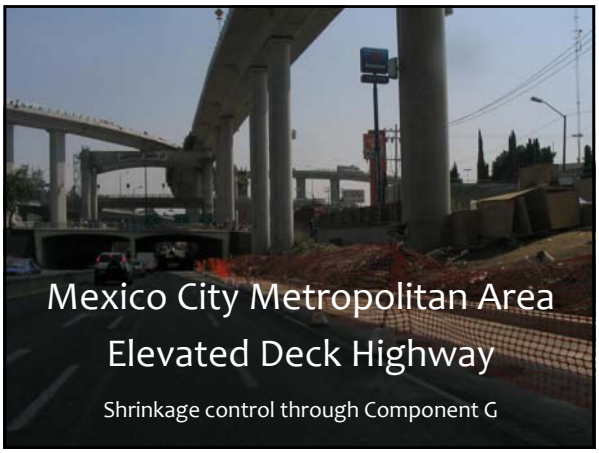
Distribution Center mix design





Highlights

- 42 pours
- 5 years in service life operation with no interruptions
- Cement content strongly influences expansion
- ASTM C 878 Lenght change history with local materials before the project design
- Owner would invest on this technology again



Elevated deck highway

- Key infrastructure project to help the transit of the Mexico City and surrounding metropolitan area that runs as an elevated deck on top of the current highway path
  - Various stages from 2004 up to date

Elevated deck highway

- Specialty concrete was required for different structural applications:
  - Post-tension girders and columns
  - Precast boards
  - Foundations
  - Girder-column conections
  - Slab support layer

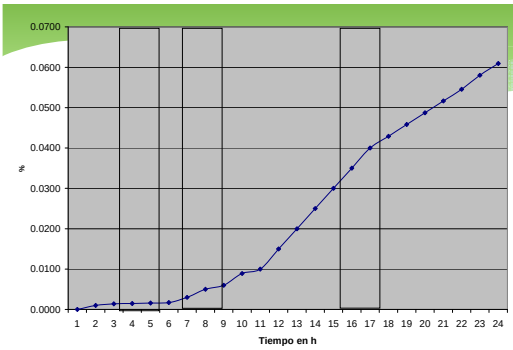
Post-tension precast girders and columns requirements

- Compressive strength
  - 60 MPa at 28 days (*f'c*)
  - 48 Mpa at 24 hours (80% *f'c*)
- Slump flow
  - 700 to 740 mm
- Placing method: pump

Girder-column conections and foundations
SSD Mix design per m^3

Cement Type CPC 40R	620	kg
Coarse agg 5-12 mm (limestone)	864	kg
River sand	657	kg
Water	220	L
HRWR polycarboxylate	6,2	L
Component G	10	kg

ASTM C 157 Lenght change at 24 hours



Support layer Technical requirements

- Compressive strength
  - 40 MPa at 14 days
- Slump
  - 120 to 140 mm
- Placing method: Pump

Support layer
SSD Mix design per m³

Cement Type CPC 40 (R)	400	kg
Coarse agg 5-12 mm (limestone)	1017	kg
River sand	720	kg
Water	181	L
Water reducing admixture	1,8	L
HRWR Eucon 37	1,0	L
Component G	10	kg

Satelite, Estado de Mexico 2009


Satelite, Estado de Mexico 2009


Satelite, Estado de Mexico 2009


San Jeronimo-Muyuguarda, Mexico City 2012

Highlights

* Mexico infrastructure plans have recognized the importance on the use of specialty concrete technology to overcome the current challenges of Civil Engineering
* Contractors, concrete ready-mix, precast and admixture companies have given an important step towards concrete technology application with stricter requirements to come

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Thanks

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Special recognition to EUCLID CHEMICAL customers in Mexico for their outstanding contribution to modern concrete technology