American Concrete Institute
Advancing concrete knowledge

SCC and HPC (70 MPa) for a Massive Block Foundation

Carlos Britez
Juan Gadea
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IBRACON
Universidade de São Paulo

PhD Engenharia
"do Laboratório de Pesquisa ao Canteiro de Obras"

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TENTH INTERNATIONAL CONFERENCE ON SUPERPLASTICIZERS AND OTHER CHEMICAL ADMIXTURES IN CONCRETE

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SCC and HPC (70 MPa) for a Massive Block Foundation

...from university lab research to job site...

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International Conferences **October 29, 2012** **Prague, Czech Republic**

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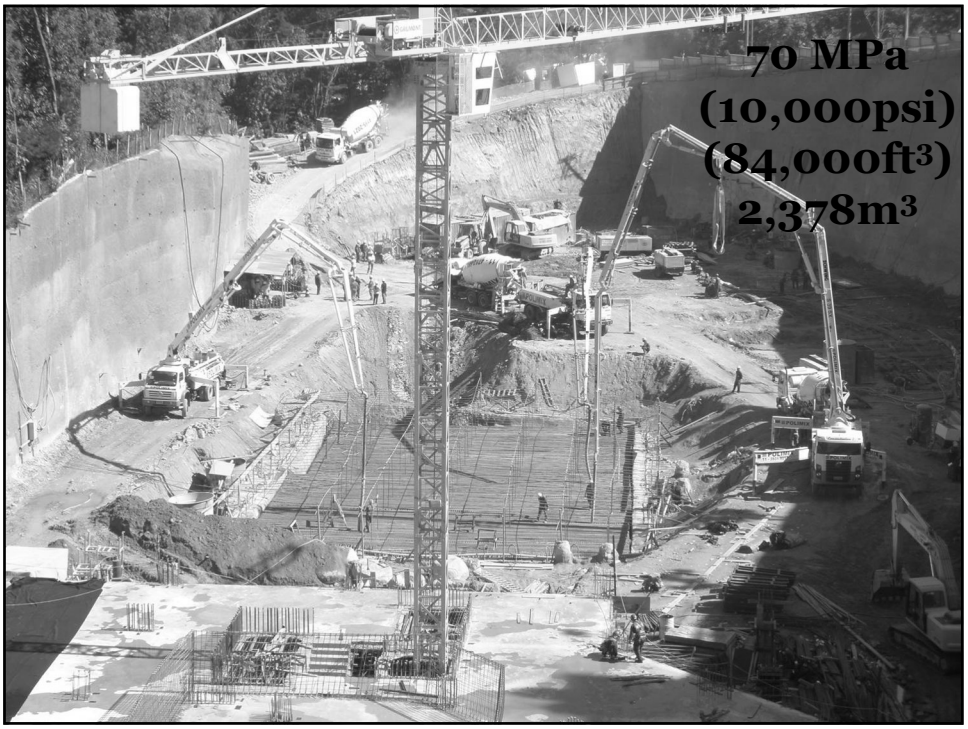
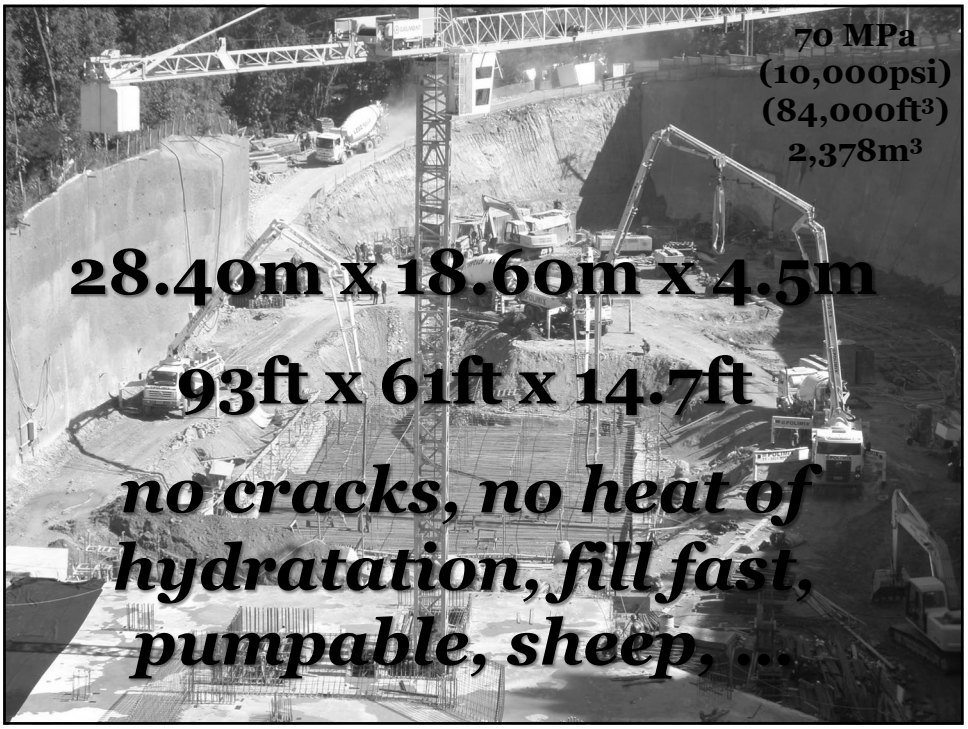

70 MPa
(10,000psi)
(84,000ft³)
2,378m³

3


70 MPa
(10,000psi)
(84,000ft³)
2,378m³
28.40m x 18.60m x 4.5m
93ft x 61ft x 14.7ft

4



5

Cement & Admixture

- 0,5% → SIKAMENT 735 plasticizer admixture
- 1% → SIKAMENT 5700 superplasticizer admixture
- ABNT NBR 11768 (S & SP)
- ASTM 494 (A & F)
- PCE modified

- compatibility tests
- blast furnace cement {60% + 40% (clinquer + gypsum)}

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World Business Council for Sustainable Development
Cement Sustainability Initiative

WBCSD → CSI, said in the "Getting the Numbers Right", 2010:

1. ..."Brazil is the leader in the use of biomass as substitute fuel, with 12% of total thermal energy generated...;

2. also ... "cement / clinquer = 0.58, one the best relation ship in the world..."

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Cement & Admixture

- **0,5% → SIKAMENT 735 plasticizer admixture**
- **1% → SIKAMENT 5700 superplasticizer admixture**
- **ABNT NBR 11768 (S & SP)**
- **ASTM 494 (A & F)**
- **PCE modified**

- **compatibility tests**
- **blast furnace cement {60% + 40% (clinquer + gypsum)}**
- **8.5% silica fume**
- **W/cementitius = 0.36**

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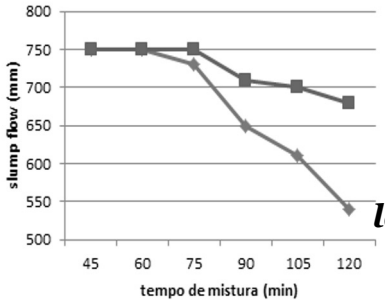
8.5% silica fume

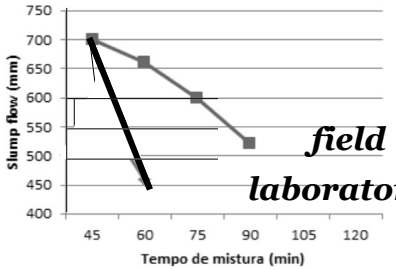


field

laboratory

.

8.5% metacaulim



field

laboratory

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5 steps procedures

- ✓ **mix design lab tests**
- ✓ **thermal simulations**
- ✓ **concrete production procedures**
- ✓ **concrete casting and control procedures**
- ✓ **technical control at site**

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5 steps procedures

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IBRACON Concrete Mix Proportion Method

optimal mortar proportion

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Mix Design Research

50days before fundation block casting

lab tests

⇩

potentials mix proportions

⇩

mixing concrete in trucks

⇩

complete field test

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Control of Materials

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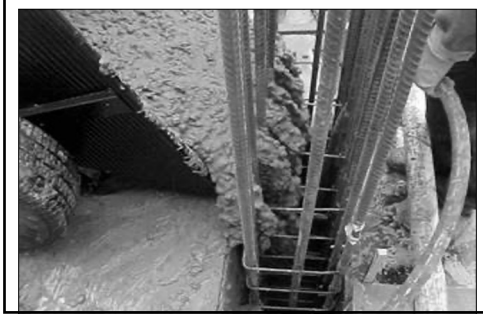
complete field test

casting parking columns
concrete no ice
slump: SCC
severe test conditions
concrete temperature 37º C
ambient temperature 32º C



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Temperature and Times

Controle de tempo	
beginning in concrete plant	12:55
go out of concrete plant	13:35
arriving at job site	14:30
finishing casting	16:00
job site concrete temperature	
37,5 ºC	

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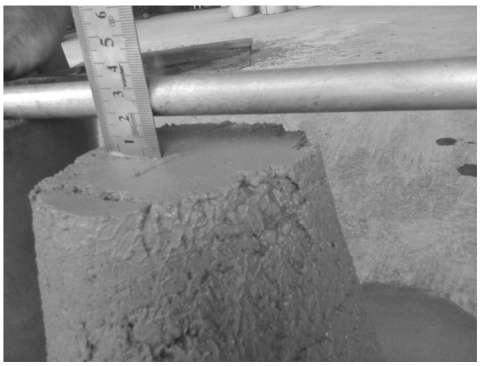
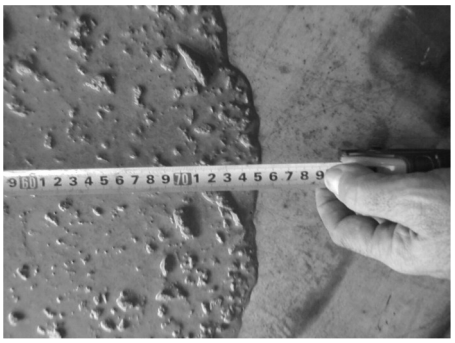
plasticizer → slump (20 – 40mm)
superplasticizer → flow (600 – 750mm)





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Density and air entrapped

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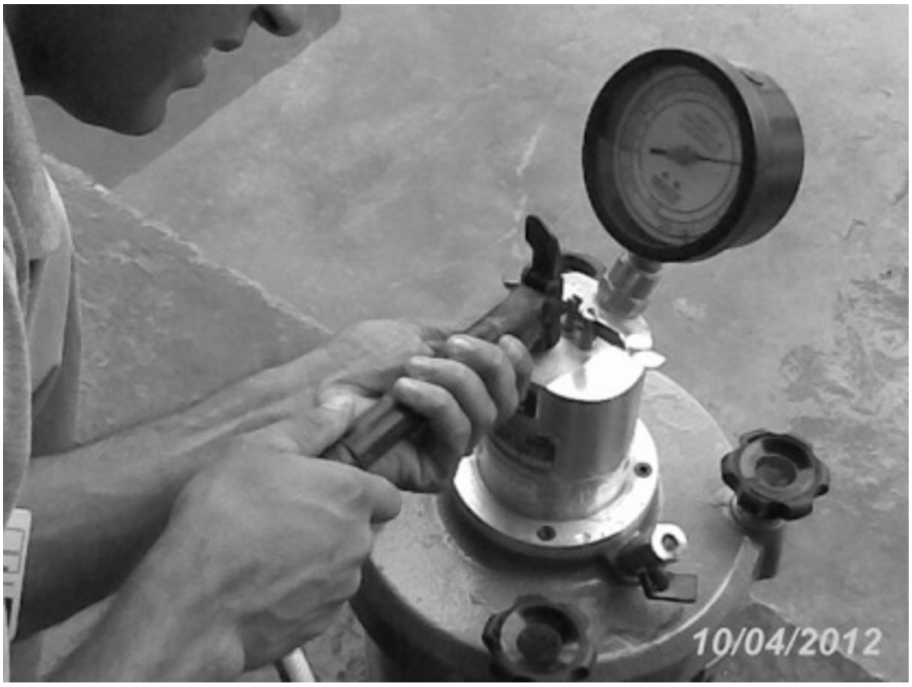

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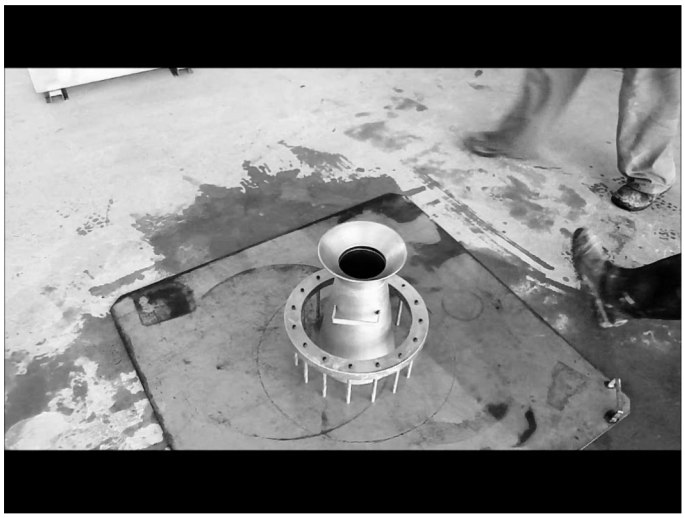
flow and t500 → NBR 15823 → Parte 2
ASTM C 1611 & EN 12350-8

21

J Ring → NBR 15823 → Parte 3
ASTM C 1621 & EN 12350-12



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L Box → NBR 15823 → Parte 4
EN 12350-10

23

V Funnil → NBR 15823 → Parte 5
EN 12350

24

Colunn segregation → NBR 15823 → Parte 6
ASTM C 1610

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Hour/Time → Temperature → RU%

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Mix Proportions per cubic meter
Mix proportions per feet cubic

Cement content	= 447kg	=	27.8 lb
Silica fume	= 38kg	=	2.4 lb
Artificial sand	= 481kg	=	30.0 lb
Natural sand	= 321 kg	=	20.9 lb
Crushed stone 9 – 19mm	= 194 kg	=	12.0 lb
Crushed stone 19 - 25mm	= 777 kg	=	48.4 lb
Total water	= 175 L	=	10.5 lb

Density = 2,438 kg/m^3
Density = 152 lb / ft^3

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Mix Proportions per cubic meter
Mix proportions per feet cubic

OPC	**= 180kg**	**=**	**11.0 lb**
Blast furnace	**= 268kg**	**=**	**16.7lb**
Silica fume	**= 38kg**	**=**	**2.4 lb**
Artificial sand	= 481kg	=	30.0 lb
Natural sand	= 321 kg	=	20.9 lb
Crushed stone 9 – 19mm	= 194 kg	=	12.0 lb
Crushed stone 19 - 25mm	= 777 kg	=	48.4 lb
Total water	= 175 L	=	10.5 lb

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5 steps procedures

- ✓ **mix design lab tests**
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- ✓ **technical control at site**

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Ice thermal calculations

Material	Consumo kg/m³	Calor específico kcal/kg.ºC	q=m.c (kcal/m³.ºC)	T (ºC)	Q (kcal/m³)
Cimento.CPIII-40	447,0	0,222	99,2	70	6946,3
Sílica	38,3	0,191	7,3	40	292,6
Areia Artificial	480,9	0,175	84,1	23	1935,6
Areia Natural	320,6	0,181	58,0	26	1508,7
Brita 0	194,2	0,175	33,9	26	883,6
Brita 1	776,8	0,175	135,9	26	3534,4
Água	134,9	1,000	134,9	26	3508,0
Umidade Miúdo Ar.	24,0	1,000	24,0	26	625,1
Umidade Miúdo Nat.	16,0	1,000	16,0	26	416,7
Umidade Graúdo	0	1,000	0	26	0
Betoneira					1000
Total			593,6604		20651,4
Transporte (Ganho)	2,0ºC				
T Lançamento=	36,8ºC				

without ice

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Ice thermal calculations

Material	Consumo kg/m³	Calor específico kcal/kg.ºC	q=m.c (kcal/m³.ºC)	Ti (ºC)	Tf (ºC)	Ti -Tf (ºC)	Q (kcal/m³)
Cimento.CPIII-40	447,0	0,222	99,2	70	0	70	6946,3
Sílica	38,3	0,191	7,3	40	0	40	292,6
Areia Artificial	480,9	0,175	84,1	23	0	23	1935,6
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Água	0	1,000	0	26	0	26	0
Umidade Miúdo Art.	24,0	1,000	24,0	26	0	26	625,1
Umidade Miúdo Nat.	16,0	1,000	16,0	26	0	26	416,7
Umidade Graúdo	0	1,000	0	26	0	26	0
Gelo	134,9	0,500	67,4	-10	0	-10	-674,6
Fusão Gelo	134,9	1,000	134,9	0	0	0	-10794,0
Gelo + Água	134,9	1,000	134,9	0	18	-18	-2428,6
Betoneira							1000
Total			796,0				3246,0
Transporte (Ganho)	2,0ºC						
T Lançamento=	6,1ºC						

with ice

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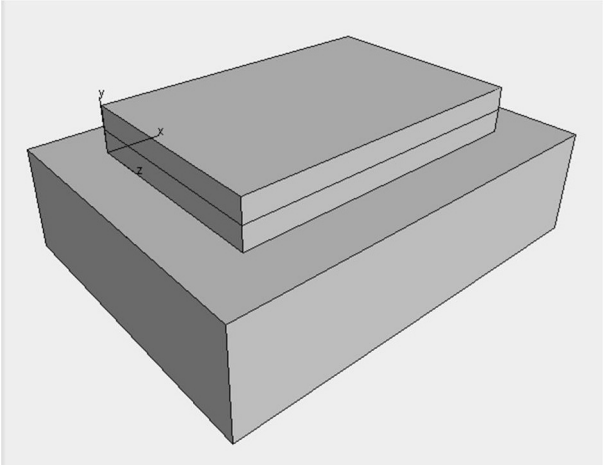
Thermal simulations for 2 layers



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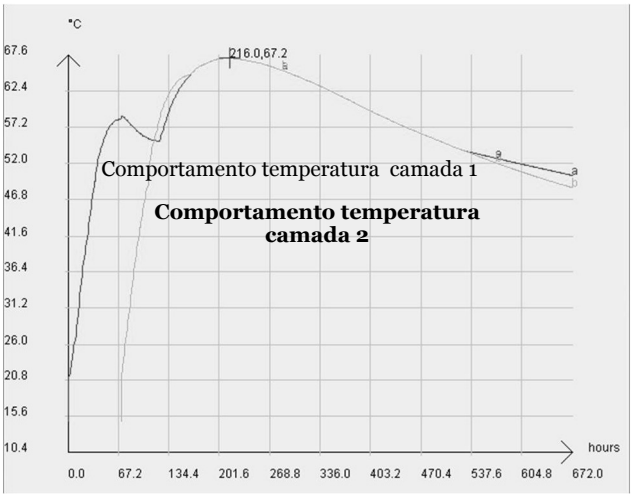
3 days → temperatures



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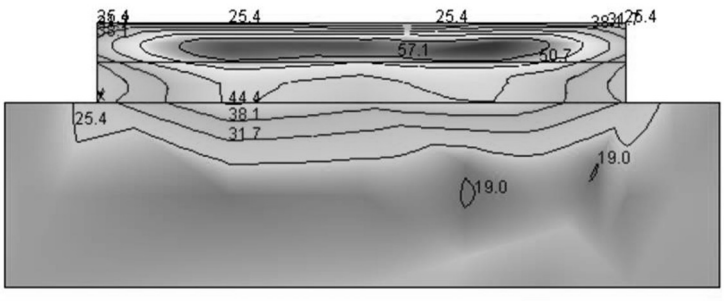
Thermal curves



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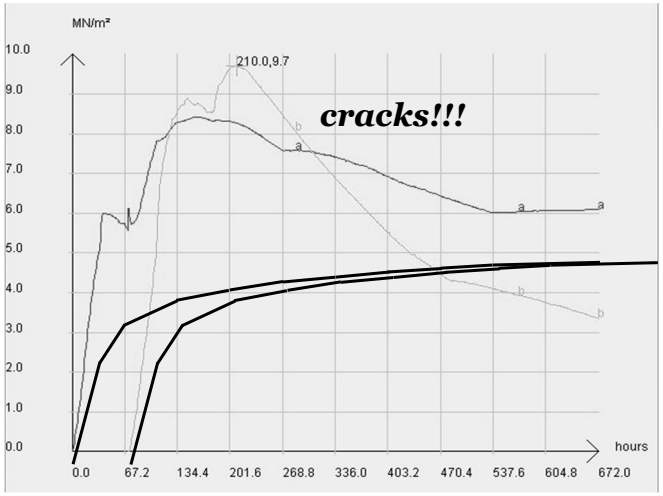
tensions



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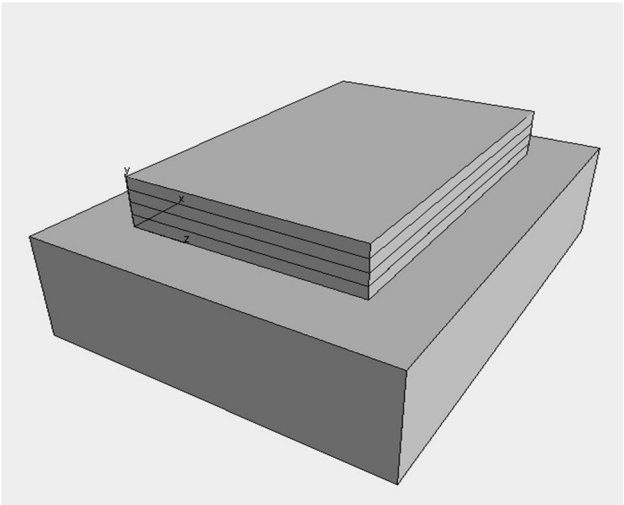
Thermal simulations 4 layers



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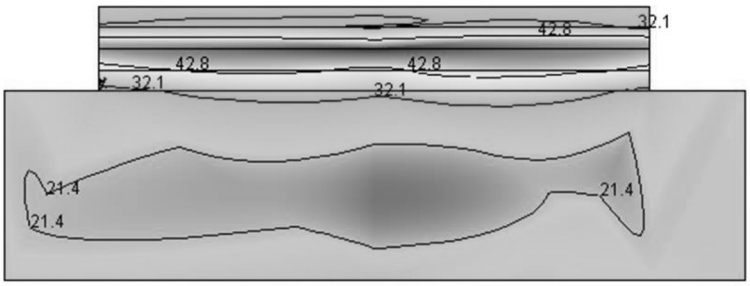
Thermal curves, 4 layers each 3days



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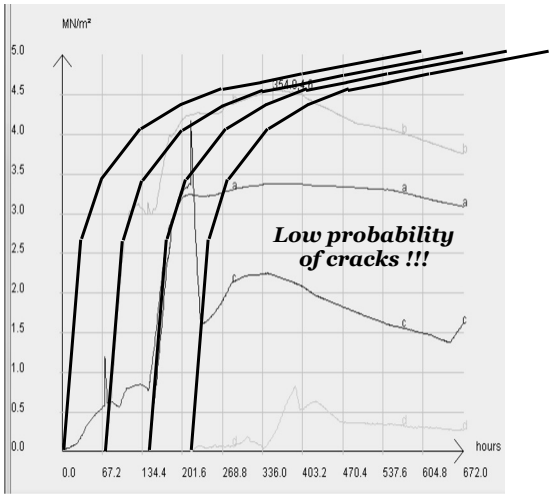
tensions



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Procedures

Concrete Production at Concrete Plant :
- **Medir temperatura agregados e cimento**
- **Molhar agregado graúdo (refrigeração)**
- **Substituição de toda a água de amassamento por gelo**
- **Pesagem dos sacos de gelo para determinar peso médio**
- **Medir umidade da areia**
- **Carregar apenas 6m³ por CB, já com aditivo**
- **Fluxo constante de caminhões betoneira**

Acceptance Control at job site :
- **Medir temperatura do concreto**
- **Medir consistência**
- **Moldar corpos de prova (compressão e módulo)**
- **Medir temperatura do concreto da viga com termopares**

Casting procedures :
- **Posicionamento bombas**
- **Precaução contra chuva**
- **Cálculo das formas**
- **Cura**

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Concrete production at Concrete Plant

Wetting aggregates

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concrete production at concrete plant ice in cubes

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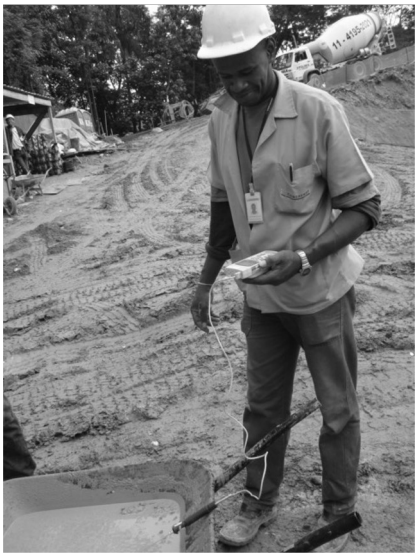
concrete temperature



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concrete flow

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Temperature control inside concrete thermal couples

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plan concrete casting in job site

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concrete casting in job site

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Why SCC?

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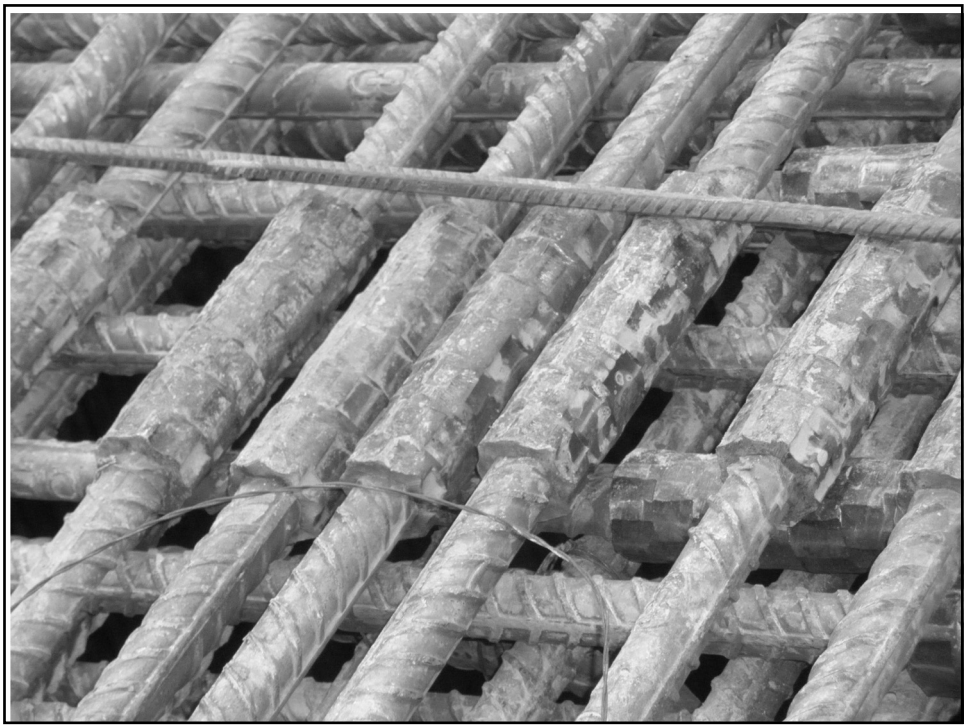

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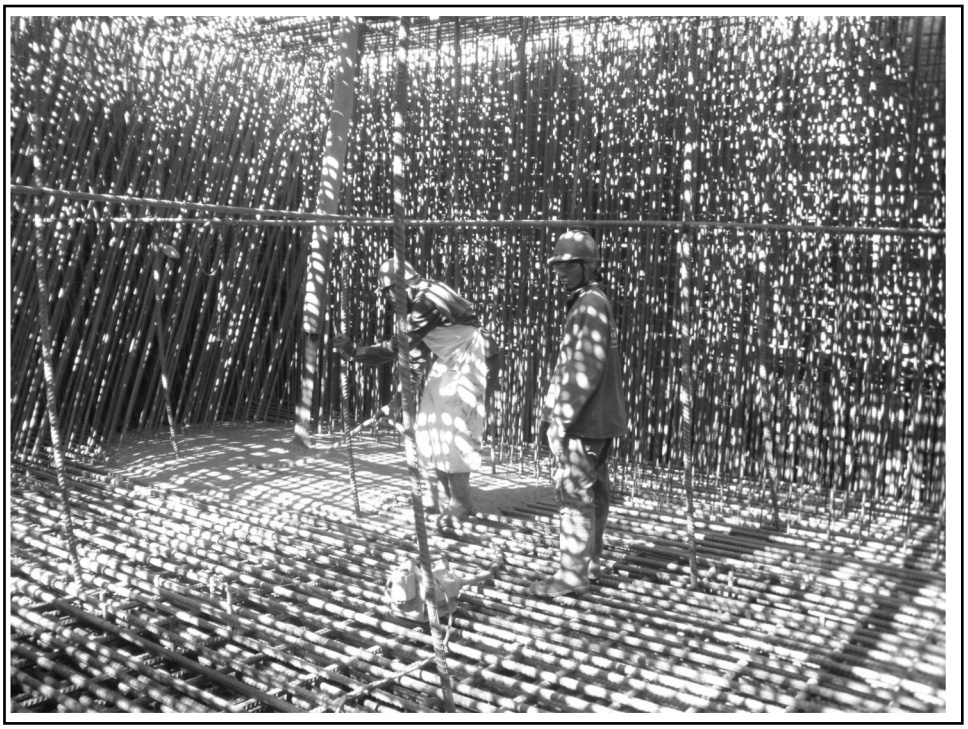

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Concrete casting

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5 steps procedures

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- ✓ **technical control**

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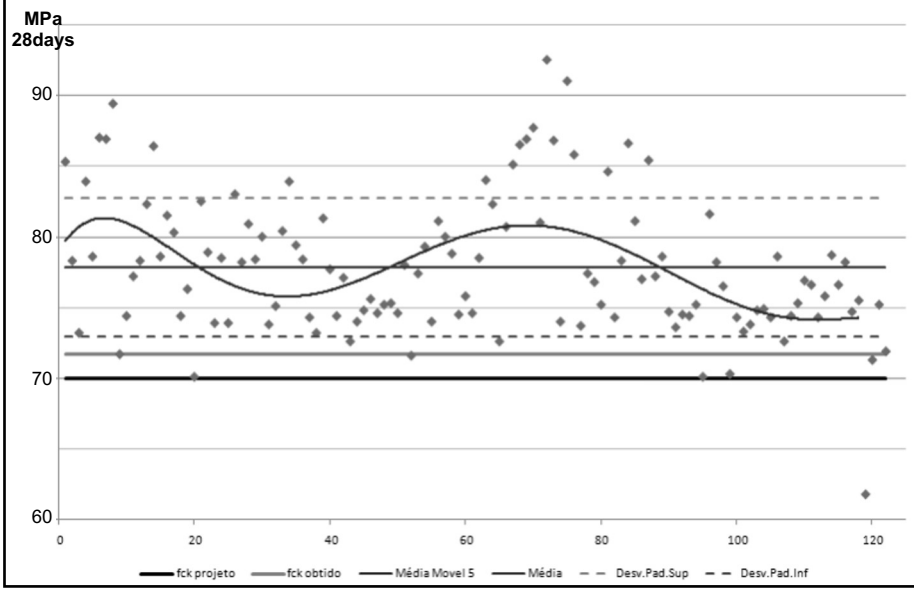
concrete strength in cylinders



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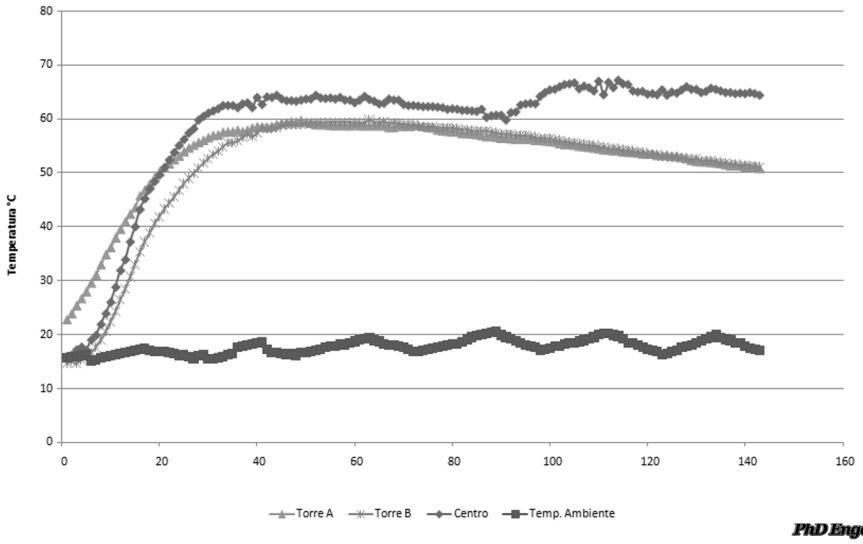
temperatures analysis



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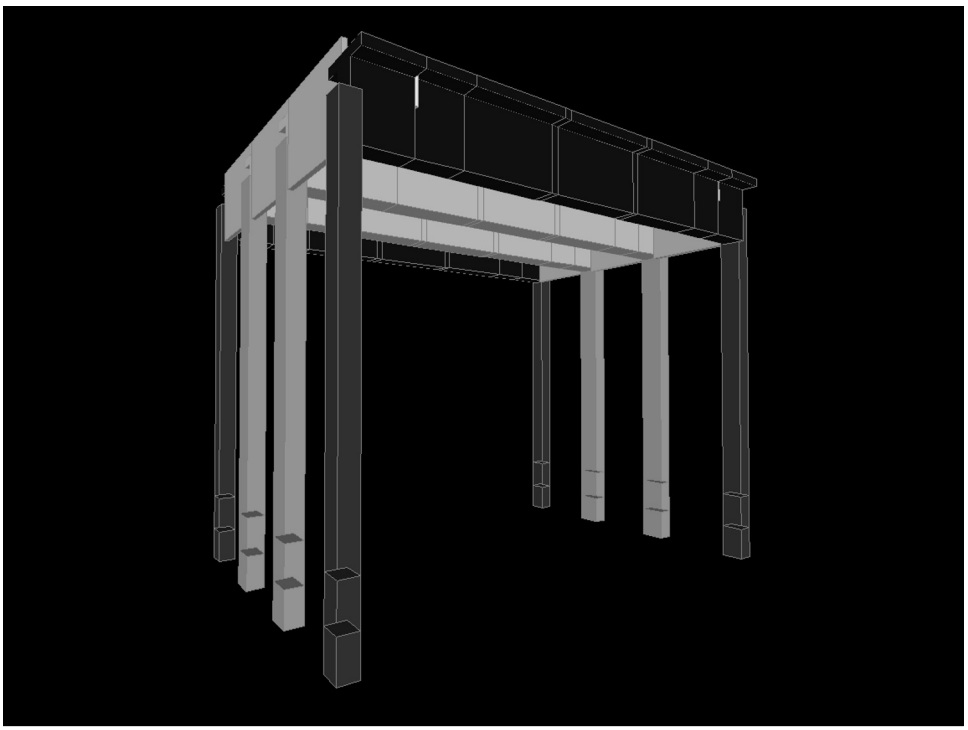

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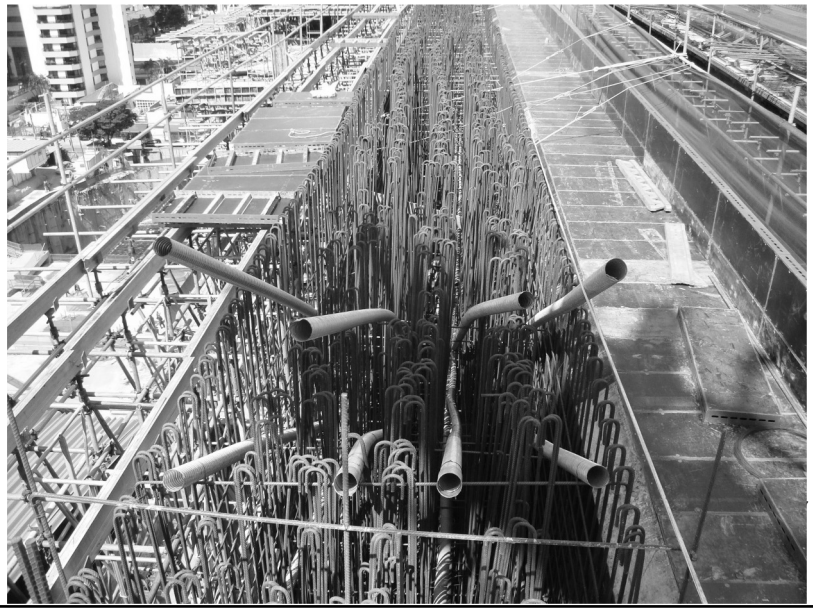
Why SCC?



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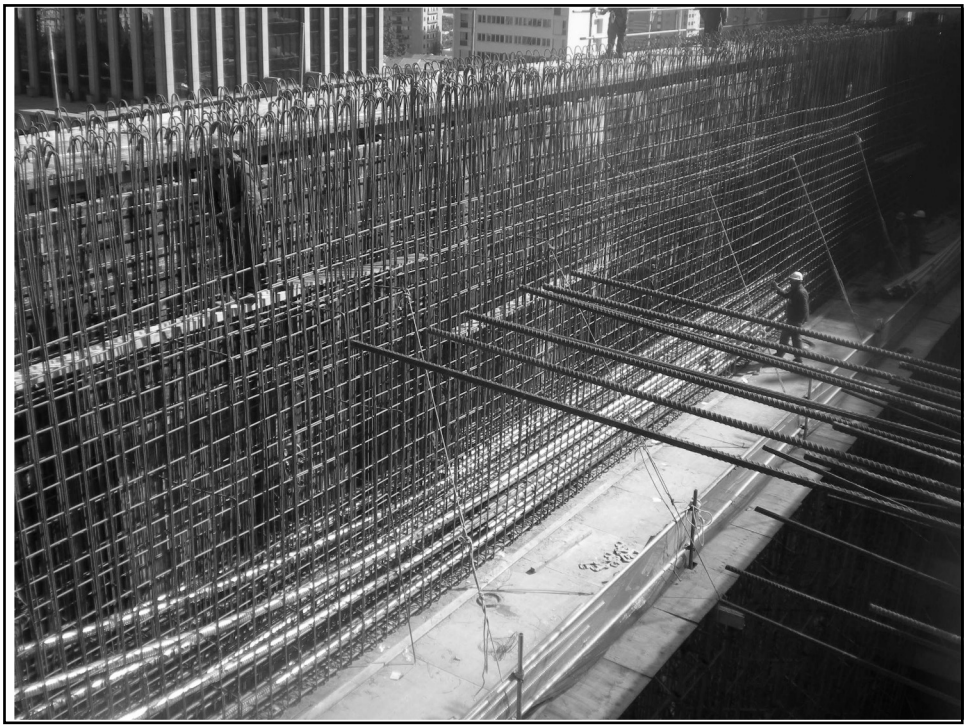

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only 2 pumps 19h

pump A

pump B

casting

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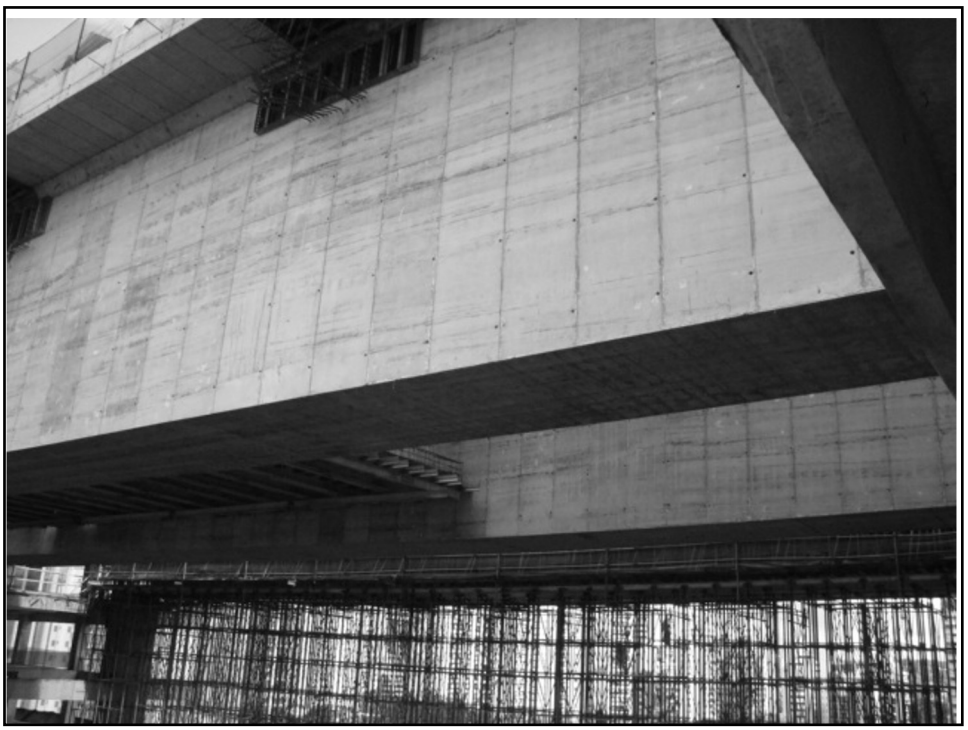

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advances in concrete technology

→ it is possible no problems

→ admixture evolution must be know

→ needs some experimental tests

→ needs to control the quality

→ needs holistic vision and SCM

→ it is a team job and SCM

→ must know standards and literature

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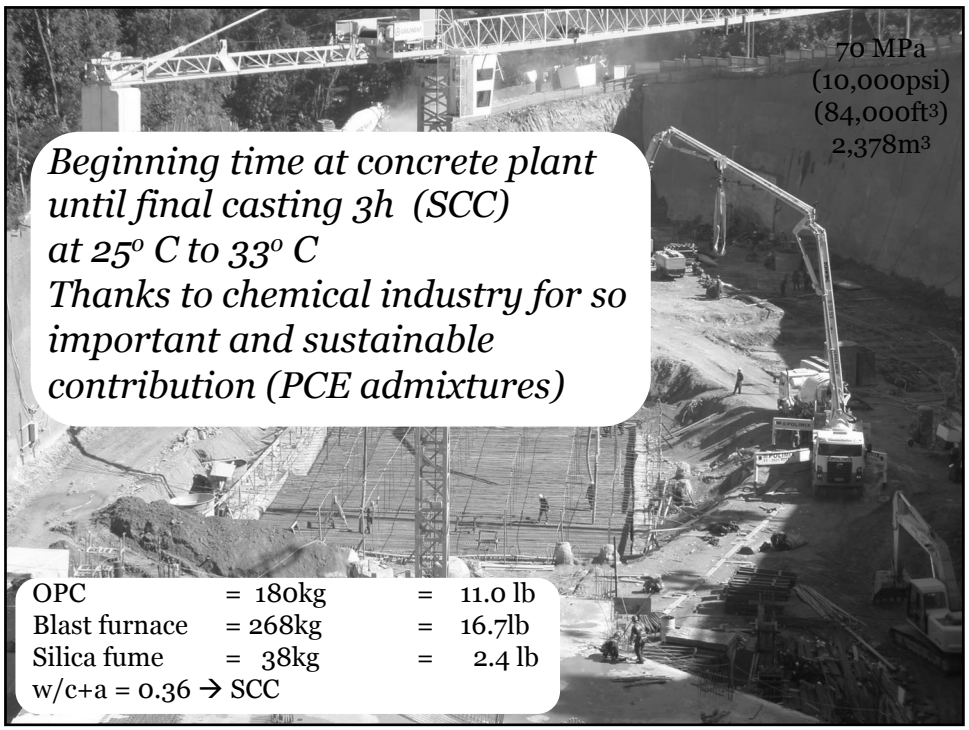

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