CONCRETE DURABILITY

JÜRG SCHLUMPF
SIKA SERVICES AG / TARGET MARKET CONCRETE

BUILDING TRUST

CONCRETE DURABILITY
SPEAKER

- **Jürg Schlumpf (Smurf)**
  Swiss; 52 years old; married; two children 20 & 22 years old

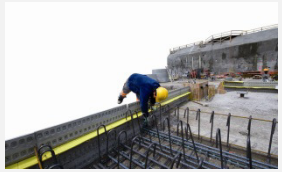
- **Education**
  Technical Draftsman, Construction Builder (Mason),
  Civil Engineer HTL, Marketing Planer FH

- **Actual position** (23 years with Sika)
  Corporate Target Market Manager Concrete

- **Highlights**
  Implementation of PCE's admixtures in Sika **Sika® ViscoCrete®**
  Development of Concrete Systems for the **Gotthard Base Tunnel**
  Build up **Concrete Academy**
  Market introduction of the **Sika® ViscoFlow®** slump retention technology

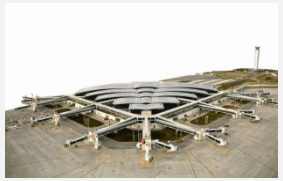
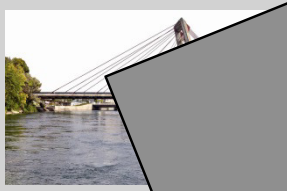
CONCRETE DURABILITY
CONCRETE REQUIREMENTS

Quality I

	**Watertight Concrete** Basement & all Infrastructure	▪ Elasticity ▪ w/c and binder concept
	**Corrosion Resistant Concrete** Harbor all structures seaside	▪ Steel surfa…on ▪ w/c…t
	**Frost & Freeze / Thaw… Resistant Con…** Bridge Re…	…res
	**…ete**	▪ Binder concept ▪ w/c
	**Fire Resistant Concrete** Railway Station Underground structure	▪ Expansion Capillary ▪ Mix Design (CEM / Aggreg.)

w/c and binder concept

CONCRETE DURABILITY
CONCRETE REQUIREMENTS
Quality II

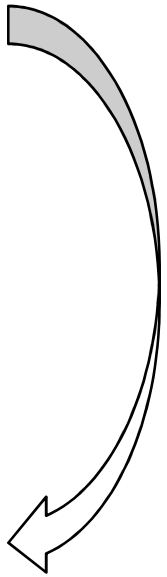
	**Alkali-Silica-Reaction Resistant Concrete** Airstrip / Highway	▪ Aggregate concept ▪ Mix design & binder concept
	**Abrasion Resistant Concrete** Discharge unit of a dam Gen. Hydro Power	▪ Surface ha ▪ Mix
	**Chemical Resistant Co** Waste water treatm	ction nd binder
		▪ w/c ▪ Binder content and concept
	**Shrinkage Controlled Concrete** All types of high durable concrete	▪ w/c ▪ Shrinkage reducer ▪ Binder content and concept

w/c and binder concept

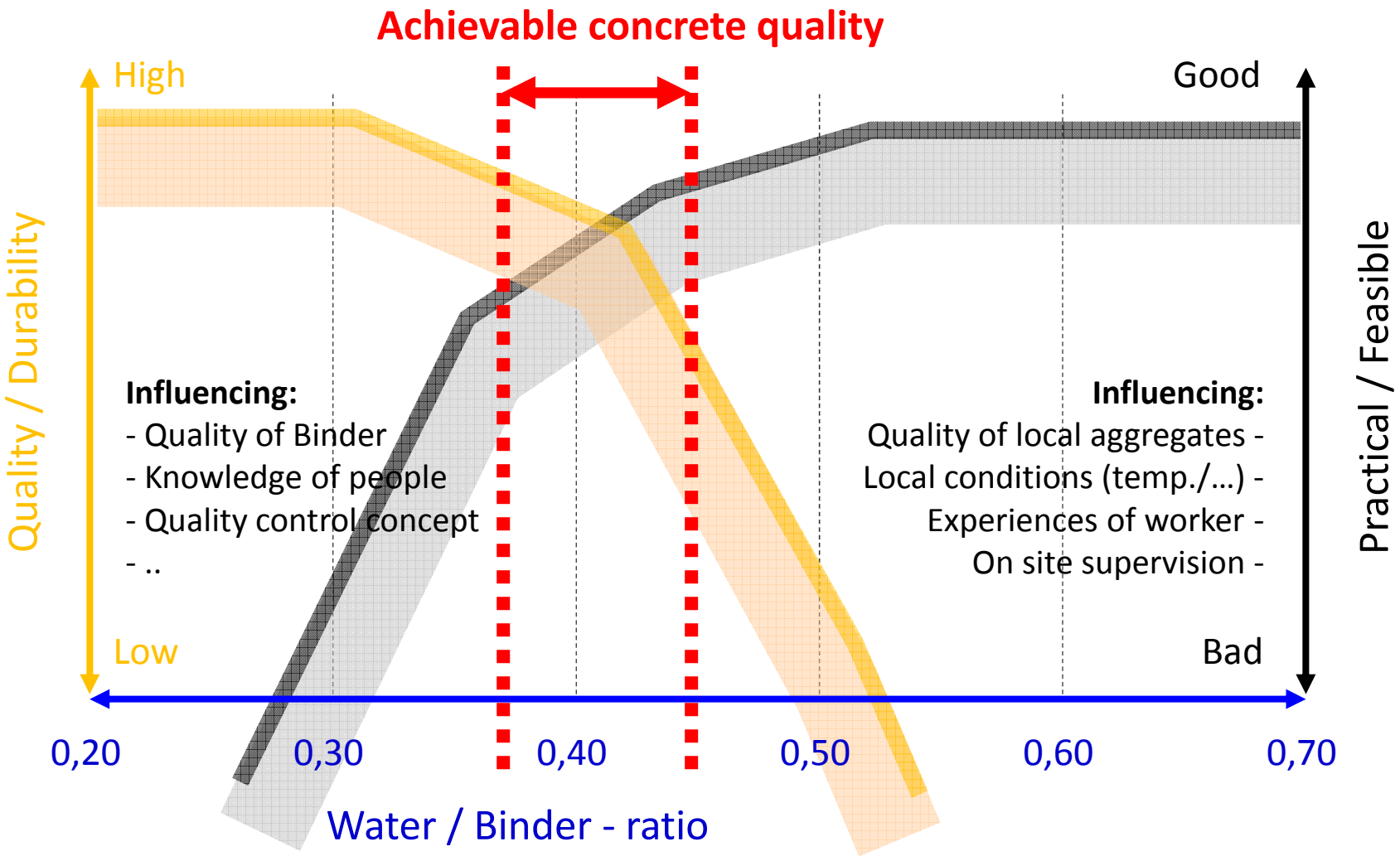
CONCRETE DURABILITY
FROM SIKA-1 TO SIKA VISCOCRETE

Concrete Porosity

Mix 1: Initial mix design					
Cement denisty				3.15	kg/m3
Cement content				320	kg/m3
Water content	173	liter		0.54	w/c-ratio
Water demand for Hydration				0.38	w/c-ratio
Difference	51	liter		0.16	w/c-ratio
Pore quantity (based on the Concrete volume)				5.1%	
Pore quantity (based on the Cement stone)				18.7%	
Mix 2: optimized Water content					
Cement denisty				3.15	kg/m3
Cement content				320	kg/m3
Water reduction by using a WR / HRWR				20%	
Water content	138	liter		0.43	w/c-ratio
Water demand for Hydration				0.38	w/c-ratio
Difference	17	liter		0.05	w/c-ratio
					Initial Mix
Pore quantity (based on the Concrete volume)				1.7%	5.1%
Pore quantity (based on the Cement stone)				6.9%	18.7%



CONCRETE DURABILITY
LIMITS OF WATER REDUCTION



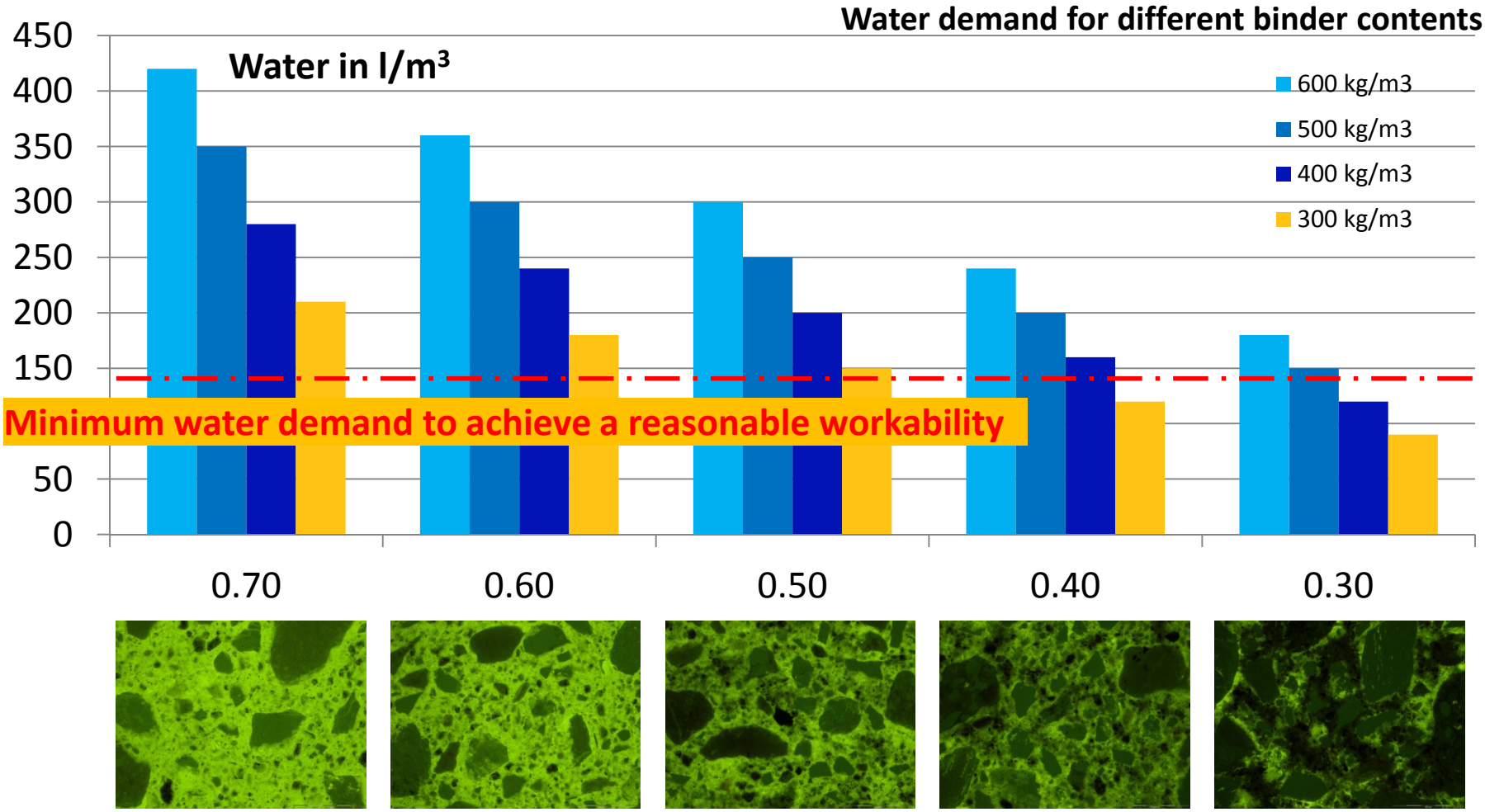
CONCRETE DURABILITY
LIMITS OF WATER REDUCTION

w/c ratio; consequences

Required w/c ratio	Therefore min. Water content	Cement content to achieve	Comments
0.50	approx. 140 l/m^3	≥ 280 kg/m^3	Workability must be ensured Example: Pumped concrete: Total ≤ 0.125mm: ≥ 400 kg/m^3 Self-compacting concrete : Total ≤ 0.125mm: ≥ 500 kg/m^3
0.40	approx. 140 l/m^3	≥ 350 kg/m^3	It must be possible to achieve the required softness (liquefaction) with water reducers (HRWR)
0.30	approx. 140 l/m^3	≥ 450 kg/m^3	Shrinkage may not over-compensate for the benefits of the low W/C, Example: Cement content 500 kg/m3: →Ɛcs (182d): 0.55‰ Cement content 250 kg/m3: →Ɛcs (182d): 0.30‰

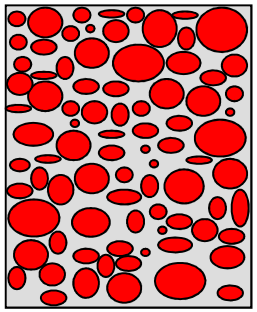
CONCRETE DURABILITY
FROM SIKA-1 TO SIKA VISCOCRETE

Water reduction limits

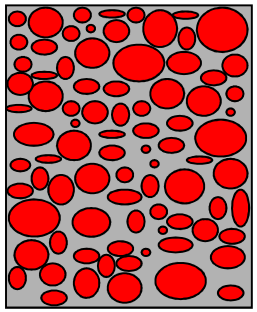


CONCRETE DURABILITY
PASTE VOLUME OPTIMIZATION

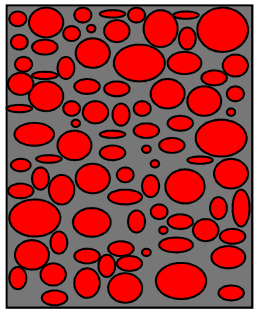
Concrete with <u>different paste quality</u> will have different mechanical strengths.



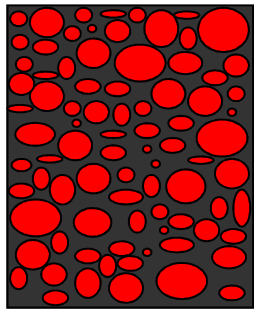
W/C=0.75
350 kg/m³
30 N/mm²



W/C=0.65
350 kg/m³
40 N/mm²



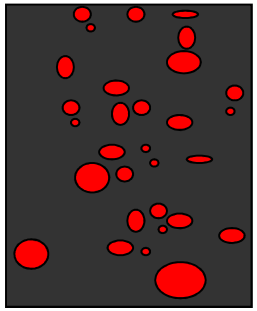
W/C=0.55
350 kg/m³
50 N/mm²



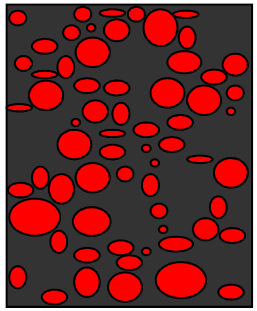
W/C=0.45
350 kg/m³
60 N/mm²

But concrete with different <u>paste volume but same paste quality</u> we will have "same" mechanical strengths.

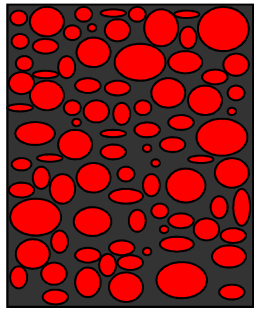
W/C=0.65
1034 kg/m³
40 N/mm²



W/C=0.65
600 kg/m³
40 N/mm²



W/C=0.65
350 kg/m³
40 N/mm²



W/C=0.65
200 kg/m³
40 N/mm²

CONCRETE DURABILITY
PASTE VOLUME OPTIMIZATION

Definition paste volume

- **“Crane & Bucket” Concrete**
  280 kg/m3 / w/c= 0.58 / 30% Sand with 10% fines (≤ 0.125mm)
  Cement paste 251 liter
  Fine paste 273 liter

  → 250l to 280l fine paste

- **Pumped Concrete**
  340 kg/m3 / w/c= 0.50 / 40% Sand with 10% fines (≤ 0.125mm)
  Cement paste 278 liter
  Fine paste 306 liter

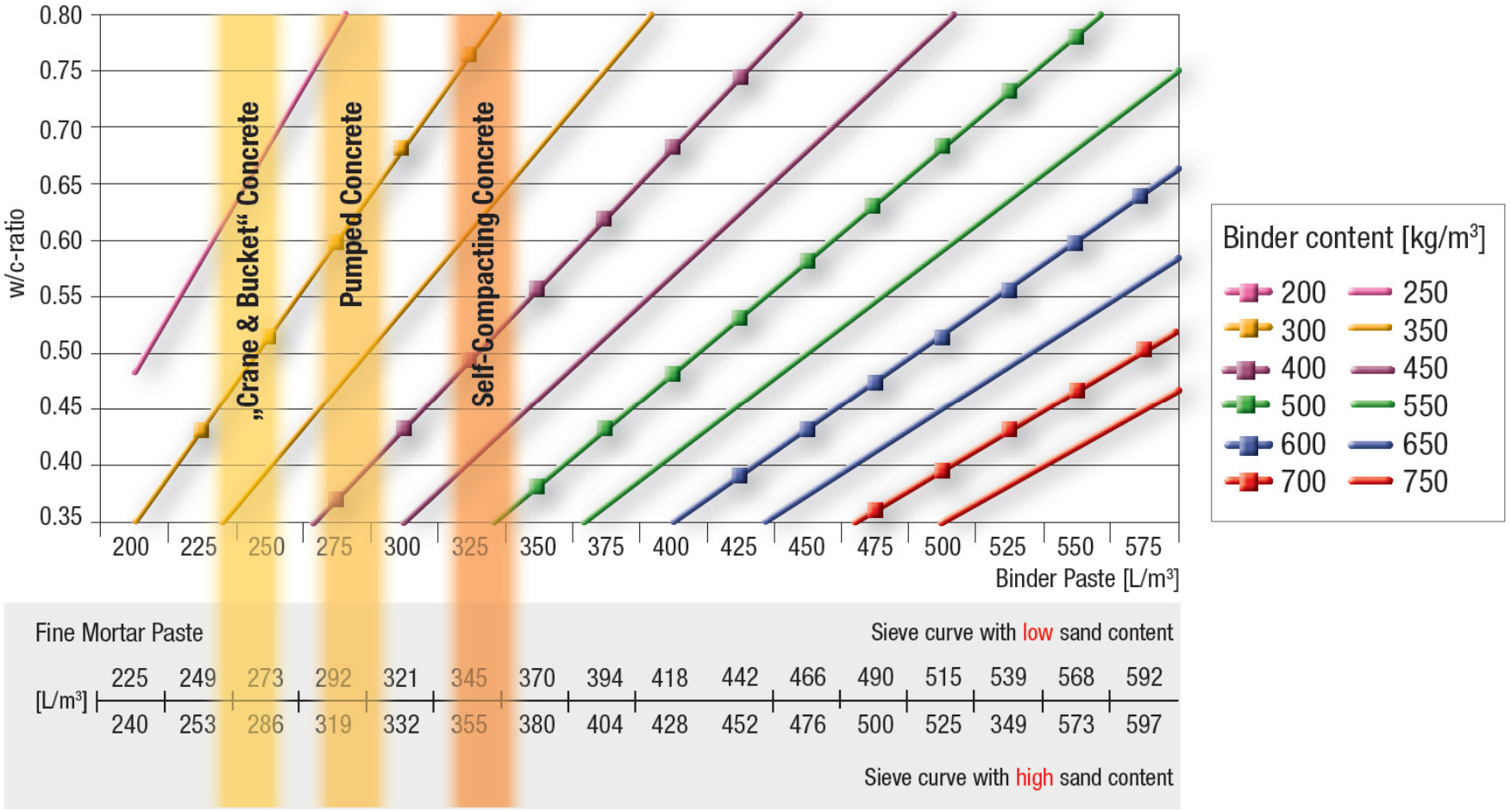
  → 280l to 320l fine paste

- **Self Compacting Concrete**
  420 kg/m3 / w/c= 0.42 / 50% Sand with 10% fines (≤ 0.125mm)
  Cement paste 310 liter
  Fine paste 343 liter

  → 320l to 380l fine paste

CONCRETE DURABILITY
PASTE VOLUME OPTIMIZATION

Definition paste volume



CONCRETE DURABILITY
COST SAVINGS – SAME PERFORMANCE

Argos Colombia

Paste Volume Optimized Concrete
with **Sika® ViscoCrete®**
Life Cycle Impact Assessment

CONCRETE DURABILITY
COST SAVINGS – SAME PERFORMANCE

Argos Colombia

Life Cycle Impact Assessment

Life Cycle Impact Assessment of two concrete systems to compare the impact of the use of **Sika® ViscoCrete®**

Concrete Systems		Components				
		Cement	Additive	Sand / Gravel	Water	Concrete Admixture
Cement paste Fina paste	290 liter 321 liter	Cement Type I 327 kg/m³	—	798 kg/m³ 916 kg/m³	w/c-ratio = 0.57 187 liter	0.56% traditional Plasticizer
Cement paste Fine paste	242 liter 275 liter	Cement Type I 273 kg/m³	—	845 kg/m³ 952 kg/m³	w/c-ratio = 0.57 155 liter	0.38% Plastiment® 0.45% Sika® ViscoCrete