Concrete Materials and Standards

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CHRYSO
CHEMICAL SOLUTIONS FOR THE CONSTRUCTION MATERIALS INDUSTRY
CHRYSO SOUTHERN AFRICA GROUP

a.b.e. Construction Chemicals (Pty) Ltd

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Introduction

- Why is specifications needed – Definition of concrete
- What is concrete? Slide 3
  - Components
  - Workability
  - Design criteria
    - Parameters – Specifications and Standards
    - Performance - Cement, Water, Admixtures, Aggregates

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So you think you know what concrete is?

Concrete is a heterogeneous system of solid discrete, gradiently sized, inorganic mineral aggregates, usually plutonic (feldspathosilicaceous or ferro-magnesian) or sedimentary-calcareous in origin, embedded in a matrix compounded of synthesised poly-basic alkaline and alkaloidal silicates held in aqueous solution and coprecipitate dispersion with other amphoteric oxides, this matrix being originally capable of progressive dissolution, hydration, reprecipitation, gelatinization and solidification through a continuous and co-existent series of crystalline, amorphous, colloidal and crypto-crystalline states and ultimately subject to thermo-allotriomorphic alteration, the system when first conjoined being transiently plastic during which stage it is impressed to a predetermined form into which it finally consolidates, thus providing a structure relatively impermeable and with useful capacity to transmit tensile, compressive and shear stresses.

(And you thought concrete was a mixture of sand, cement, aggregate and water?)

With acknowledgement to "The Civil Engineering Contractor" Edition and Date Unknown.

What is concrete? Components

- **A mix of several components:**
  - Aggregates ⇨ matrix
  - Cement ⇨ binder
  - Water ⇨ binder + porosity
  - Admixtures ⇨ modify the properties

Components	Aggregates	Water	Cement	Air	Admixtures
Volume (%)	60 - 78	14 - 22	7 - 14	1 - 6	< 2

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What is concrete?
Workability

	Concrete consistence	Slump	Method of compacting
	Firm (F)	0 - 4 ± 1 cm	Extrusion Pressed with vibration Pressed
	Plastic (P)	5 - 9 ± 2 cm	Vibration
	Very plastic (VP)	10 - 15 ± 3 cm	Slight vibration
	Flowing (FL)	16 ± 3 cm Flow test	Very slight vibration

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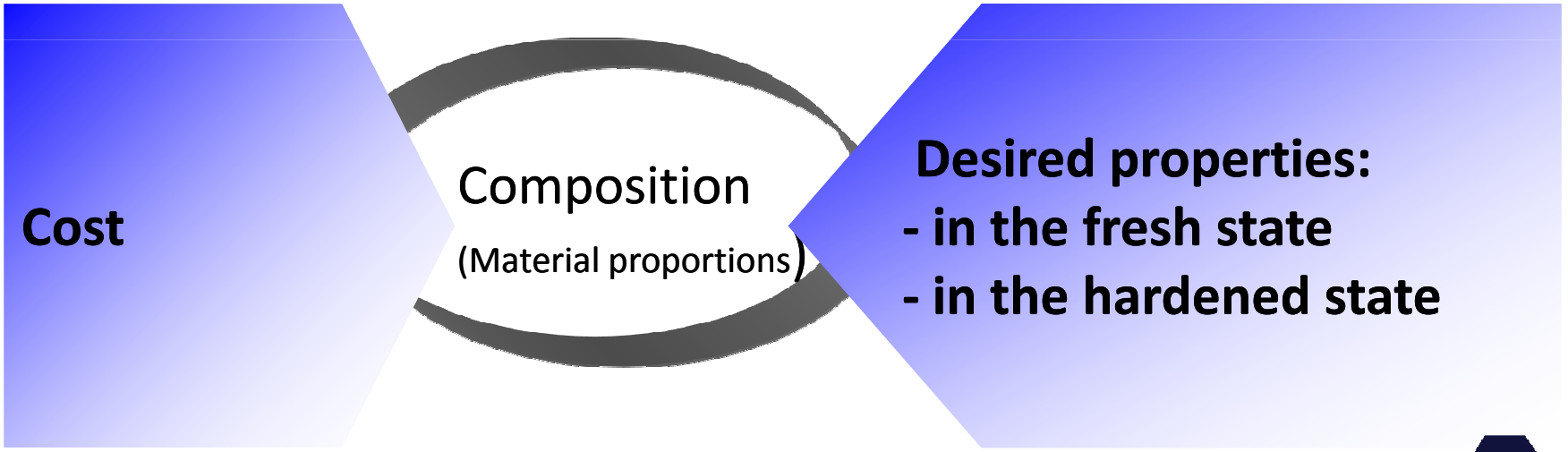
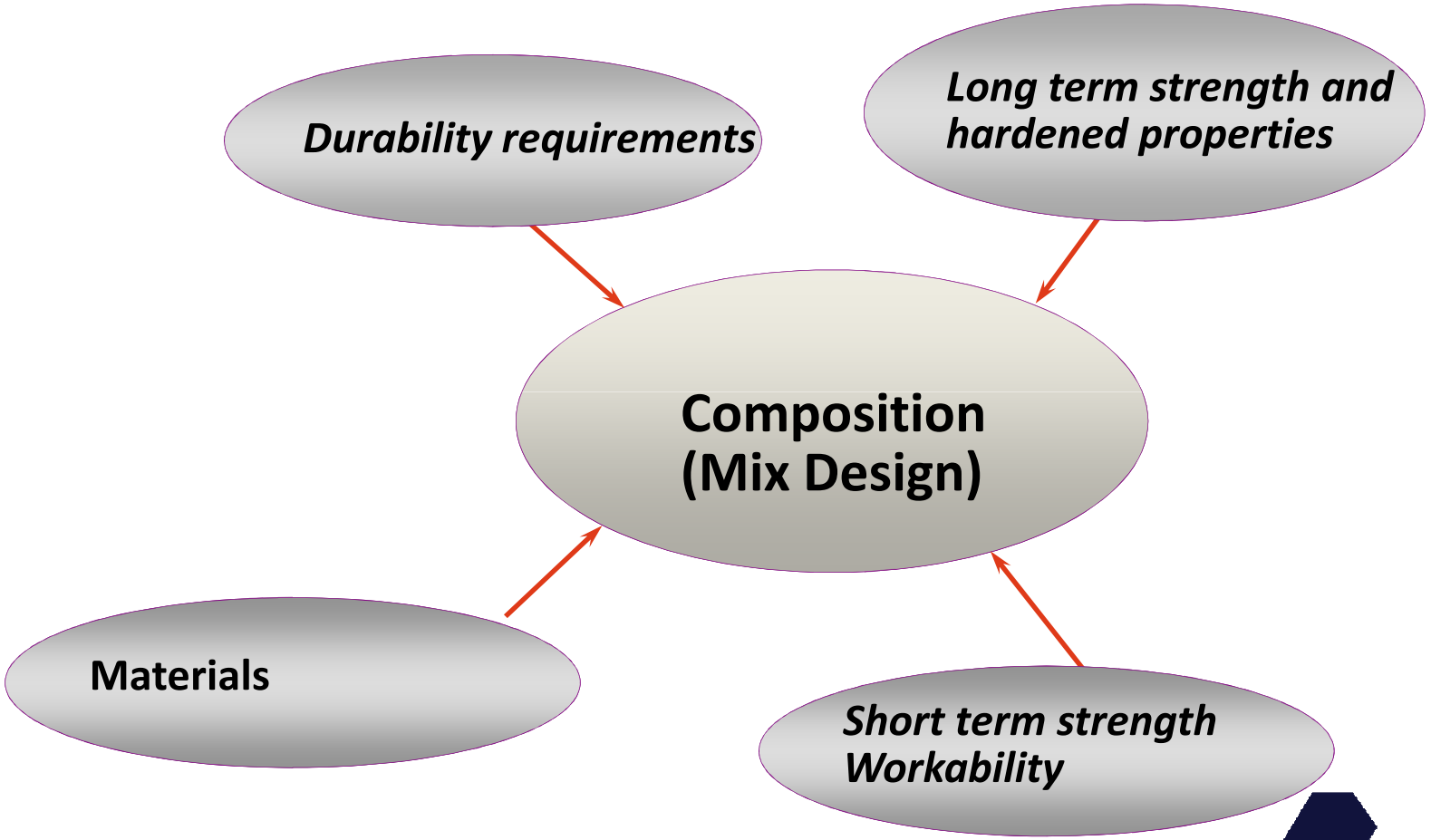
Design Parameters

- The Design is the result of a compromise:



Design Parameters



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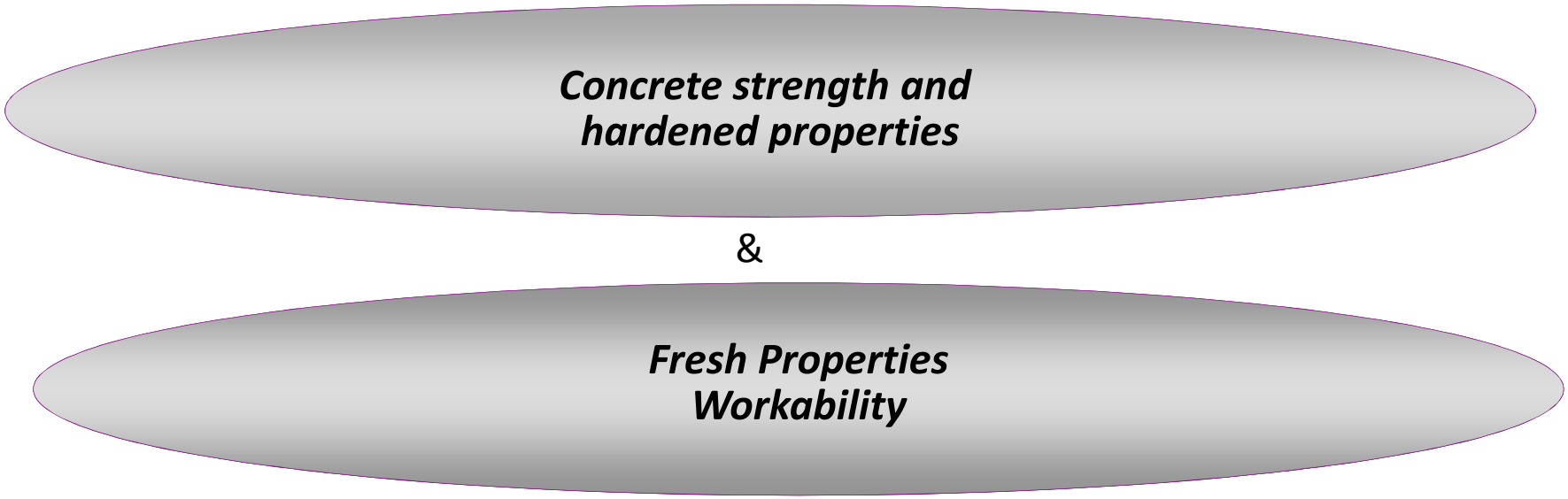
Durability requirements

- No single specification….
- If used correctly, standards and codes provide a framework for durable concrete
- Preparation, OPI, and CC currently with SABS to be introduced as SANS 3001 CO3?



- PSG
- SANS 2001 CCI
- SANS 5861-1, 2, 3
- SANS 5863
- SANS 5864
- SANS 10100

To be included under New SANS 3001 CO1, CO2 and CO3 series of test methods (2013)

Materials (Cementitious)

- Cement – SANS 50197
- Fly Ash SANS 50450
- Slag SANS 55167
- Silica Fume SANS 53263
- Limestone?
- Others?

Cement standards

What does this mean?

- All common cement sold in South Africa must bear the SANS 50197-1 mark
- Cement is sold by Strength Category
- Cement is classified by mineral component type and percentage

Cement Types in South Africa

- Portland Cement CEM I
- Portland Composite Cement CEM II
- Blastfurnace Cement CEM III
- Pozzolanic Cement CEM IV
- Composite Cement CEM V

Composition…27 cement types

Table 1.1: Common cements: SABS EN 197-1

Main types	Notation of products (types of common cement)		Composition, percentage by mass[a]										
			Clinker	Blast-furnace slag	Silica fume	Pozzolana		Fly ash		Burnt shale	Limestone		Minor additional constituents
						natural	natural calcined	siliceous	calcareous				
			K	S	D[b]	P	Q	V	V	T	L	LL	
CEM I	Portland cement	CEM I	95 - 100	-	-	-	-	-	-	-	-	-	0 - 5
CEM II	Portland-slag cement	CEM II A-S	80 - 94	6 - 20	-	-	-	-	-	-	-	-	0 - 5
		CEM II B-S	65 - 79	21 - 35	-	-	-	-	-	-	-	-	0 - 5
	Portland-silica fume cement	CEM II A-D	90 - 94	-	6 - 10	-	-	-	-	-	-	-	0 - 5
	Portland-pozzolana cement	CEM II A-P	80 - 94	-	-	6 - 20	-	-	-	-	-	-	0 - 5
		CEM II B-P	65 - 79	-	-	21 - 35	-	-	-	-	-	-	0 - 5
		CEM II A-Q	80 - 94	-	-	-	6 - 20	-	-	-	-	-	0 - 5
		CEM II B-Q	65 - 79	-	-	-	21 - 35	-	-	-	-	-	0 - 5
	Portland-fly ash cement	CEM II A-V	80 - 94	-	-	-	-	6 - 20	-	-	-	-	0 - 5
		CEM II B-V	65 - 79	-	-	-	-	21 - 35	-	-	-	-	0 - 5
		CEM II A-W	80 - 94	-	-	-	-	-	6 - 20	-	-	-	0 - 5
		CEM II B-W	65 - 79	-	-	-	-	-	21 - 35	-	-	-	0 - 5
	Portland-burnt shale cement	CEM II A-T	80 - 94	-	-	-	-	-	-	6 - 20	-	-	0 - 5
		CEM II B-T	65 - 79	-	-	-	-	-	-	21 - 35	-	-	0 - 5
	Portland-limestone cement	CEM II A-L	80 - 94	-	-	-	-	-	-	-	6 - 20	-	0 - 5
		CEM II B-L	65 - 79	-	-	-	-	-	-	-	21 - 35	-	0 - 5
		CEM II A-LL	80 - 94	-	-	-	-	-	-	-	-	6 - 20	0 - 5
		CEM II B-LL	65 - 79	-	-	-	-	-	-	-	-	21 - 35	0 - 5
	Portland-composite cement[c]	CEM II A-M	80 - 94	◄----------				6 - 20				----------►	0 - 5
		CEM II B-M	65 - 79	◄----------				21 - 35				----------►	0 - 5
CEM III	Blastfurnace cement	CEM III A	35 - 64	36 - 65	-	-	-	-	-	-	-	-	0 - 5
		CEM III B	20 - 34	66 - 80	-	-	-	-	-	-	-	-	0 - 5
		CEM III C	5 - 19	81 - 95	-	-	-	-	-	-	-	-	0 - 5
CEM IV	Pozzolanic cement[c]	CEM IV A	65 - 89	-	◄----------		11 - 35		----------►	-	-	-	0 - 5
		CEM IV B	45 - 64	-	◄----------		36 - 55		----------►	-	-	-	0 - 5
CEM V	Composite cement[c]	CEM V A	40 - 64	18 - 30	-	◄--	18 - 30		--►	-	-	-	0 - 5
		CEM V B	20 - 39	31 - 50	-	◄--	31 - 50		--►	-	-	-	0 - 5

Notes

(a) The values in the table refer to the sum of the main and minor additional constituents.

(b) The proportion of silica fume is limited to 10%.

(c) In portland-composite cements CEM II A - M and CEM II B - M, in pozzolanic cements CEM IV A and CEM IV B, and in composite cements CEM V A and CEM V B the main constituents other than clinker shall be declared by designation of the cement.

Description of cement types...

- 27 allowable compositions
- 3 strength classes…32,5 42,5 52,5
- 2 options for early strength development…
  Normal and Rapid hardening

Total = 27 x 3 x 2 = 162 possible cement products

Limestone

- Limestone as a mineral component is relatively new in South Africa (since 1994), however it has been extensively used in Europe for many years.
- **SANS 50197-1** for Common Cements allows a maximum of 35% of this mineral component to be incorporated into cements. With the correct chemical composition and suitable fineness, limestone enhances the technical and economical properties of concrete.

GGBS

- Ground Granulated Blastfurnace Slag (Slagment) (GGBS) is a by-product from the steel industry
- Hot slag from the Blastfurnace, where iron is made, is rapidly quenched with water and milled to a fine powder.

Final product - Slagment(GGBS)

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SLAGS

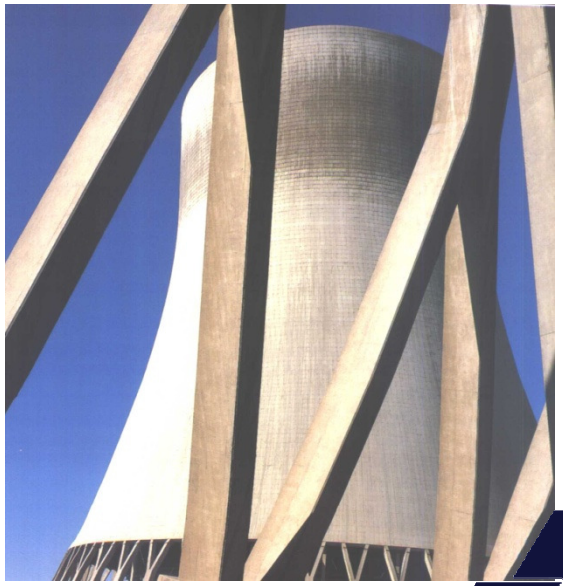
Types and producers of Slag:

- GGBS (Slagment, Vanderbijlpark)
- GGBS (Slagmore, NPC-Cimpor, Newcastle)
- GGCS (PPC, Saldanha)
- Ferro-Manganese Slag (Samancor, Enviroslag, Middelburg)

Final product - Slagment(GGBS)

Pulverised Fuel Ash (PFA)

- PFA is the ash produced from the combustion of powdered coal during the process of raising steam for the generation of electric power.



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Types of (PFA) and suppliers

Classified Fly Ash

Unclassified Fly Ash

Suppliers:

- **Ash Resources** ex Matla, Kendal, Lethabo.
- **Sephaku** ex Kendal.
- **Ulula Ash** ex Kriel.

Materials (Aggregates)

- SANS 1083
- Revision to SANS 10100?
- Adoption of En 1992, EN 206 and EN 13670?
- CHANGES TO LOCAL SPECIFICATIONS?

SANS 1083 – Sand specification

Sieve size, mm	Cumulative Percentage passing sieve			
	Limits: SANS 1083		Recommended by C&CI	
4.75	90-100		90-100	
2.36	-		75-100	
1.18	-		60-90	
0.60	-		40-60	
0.30	-		20-40	
0.15	5-25		10-20	
0.075	Natural sand, max 5.	Crusher sand, max 10.	Natural sand: 5-10	Crusher sand: 5-20

SANS 1083 – Stone specification

Nominal aperture size of sieve, mm	Nominal size of aggregate, mm							
	75.0	53.0	37.5	26.5	19.0	13.2	9.5	6.7
75.0	100	100						
53.0	0-50	85-100	100					
37.5	0-25	0-50	85-100	100				
26.5	0-5	0-25	0-50	85-100	100			
19.0		0-5	0-25	0-50	85-100	100		
13.2			0-5	0-25	0-50	85-100	100	
9.5				0-5	0-25	0-55	85-100	100
6.7					0-5	0-25	0-55	85-100
4.75						0-5	0-25	0-55
2.36							0-5	0-25
1.18								0-5
Dust Content	Not to exceed 2.0%							

Variations to SANS Specifications

- Project Specific Guide may require unique aggregate properties.
- Applications may dictate the type and nature of materials.
- Alternative gradings are permitted, provided it is detailed by the purchaser.

Materials
(Water and admixtures)

- SANS 51008
- SANS 50934
- Already based on EN standards

WATER FOR MIXING CONCRETE

LIMIT TEST FOR MIXING WATER:

- Test in accordance with SANS 51008.

Two sets of concrete cubes are made, if possible using the materials and mix proportions to be used on the site. One set should be made with the suspect water, and a second control set with water from a known, reliable source.

The compressive strength of the “test” cubes at 28 days should be no less than 90% of the control cubes.

WATER FOR MIXING CONCRETE

Use of water in concrete:

- Normally the simplest to add
- Has the greatest influence on plastic and hardened properties
- If the gauging is accurate, it can be used to:

  Detect changes in material properties

  Batching or scale errors

Chemical Admixtures

In SA, admixtures are formulated to comply with ASTM C 494 or EN 934 specifications

SANS 50934 -1&2 have been adopted in SA and is a voluntary specification

- Normal plasticisers (Water Reducing Agents)
- Superplasticisers (High Range Water Reducing Agents)
- Retarders and Plasticising Retarders
- Accelerators (Set and Strength development)
- Air Entrainers
- Water Proofing
- Retarded Mortars
- Grout admixtures

Introduction to Chemical Admixtures

Admixtures which are not covered by specifications

- Foamed Concrete and Low Density Fill Material
- Corrosion Inhibitors
- Pumping Aids
- Anti-washout Admixtures
- Polymer dispersions
- Shrinkage reducing Admixtures

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THANK YOU

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