WATERTIGHT CONCRETE CONSTRUCTION

20 FEBRUARY 2015, MIKE LEWIS
SIKA AG / TARGET MARKET CONCRETE

BUILDING TRUST

SIKA AT A GLANCE

- Global specialty chemicals company
- Supplying construction markets and the manufacturing industry
- Headquarters in Baar, Switzerland
- Founded in 1910
- Sales of CHF 5.14 billion (2013)
- Over 16,000 employees
- In 84 countries

BUILDING TRUST

TARGET MARKETS


Concrete


Waterproofing


Roofing


Flooring


Sealing & Bonding

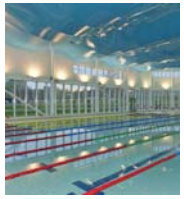

Refurbishment


Industry

BUILDING TRUST

SIKA WATERTIGHT CONCRETE

- Combining expertise and knowledge in both Concrete and Waterproofing
- Keeps water in or out or both
- No additional work to be carried out of site i.e no installation of secondary waterproofing material



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WATERTIGHT STRUCTURES
BELOW GROUND STRUCTURES

General Categorization

- Parking garages
- Equipment / Plant Rooms
- Habitable environments
- Archives

MONTEVETRO, GOOGLE EUROPEAN HQ, DUBLIN, IRELAND
SIKA WATERTIGHT CONCRETE

Project Description
Montevetro is one of the tallest commercial buildings in Dublin. It comprises 19,500 square metres of prime office space spread over 15 floors, and is located on the water's edge on the Grand Canal Basin in Dublin. The development is owned by Google and is part of its European headquarters.

Sika Solution
To ensure a dry environment in the basement car park, consulting engineers Arup specified the Sika® Watertight Concrete.

WATERPROOFING MATERIALS AND TYPES
TRADITIONAL WATERPROOFING MATERIALS

Bentonite Sheets and Membranes

Torch-on Bitumen Sheets

Cold Applied Bitumen

Modified cement tanking mortars and slurries

WATERPROOFING MATERIALS AND TYPES
MODERN WATERPROOFING MATERIALS

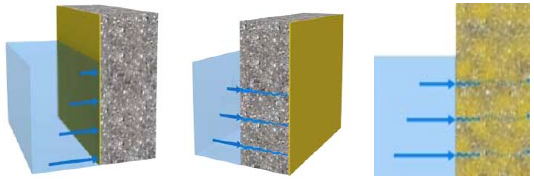
Synthetic Sheet Membrane

Liquid Applied Membrane

Watertight Concrete

Cavity Drain

WATERPROOFING MATERIALS AND TYPES
WATERPROOFING TYPES



TYPE 1
External Barrier .

TYPE 2
Internal Barrier

TYPE 3
Integral Barrier

SIKA WATERTIGHT CONCRETE CONSTRUCTION

Advantages

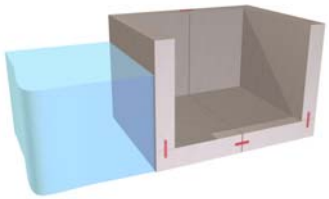
- Reduced excavation leading to a reduction in cost of work and waste
- No additional work to be carried out of site i.e no installation of secondary waterproofing material
- No external access required reducing the applied risk and cost
- Maximum building footprint enables the Owner to maximise the investment
- Effective barrier to water
- Good steel protection with improve durability
- Robust in use with reduced risk of damage during construction

SIKA WATERTIGHT CONCRETE CONSTRUCTION

Disadvantages

- Depends on good concrete practise and quality control
- Not suitable for ground conditions with extreme exposure to aggressive chemical and gases without additional measures

SIKA WATERTIGHT CONCRETE CONSTRUCTION



Definition

- The water resistance of concrete is defined by the amount of water or moisture emerging on the opposite side to that being attacked by water

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY

- Cement
  - Minimum Binder Content 350 kg/m³
  - Maximum SCM 40 % (GGBS & Fly Ash)

- Water
  - Maximum water cement ratio of 0.45

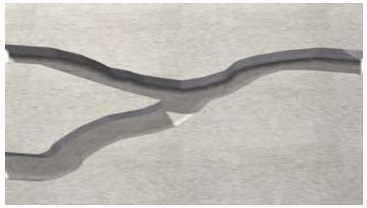
SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY

- Aggregates
  - Use concrete mix designs with maximum size of approximately 32mm
  - Select a balanced particle-size distribution curve
  - Recycled aggregate should not be used
- Additions
  - Use specific additions for systematic improvement of the concrete properties as required

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY

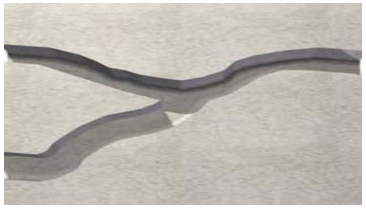
- Admixtures
  - A superplasticiser is required to ensure water cement ratio and initial flow and workability over time
  - Sika® WT to ensure watertightness

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY



Despite the apparent density of concrete it can be described as a porous material that allows the passage of water through a connected structure of capillary pores

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY



Capillarity

Capillaries are the voids created in concrete by the excess water that is needed to support placement (workability)

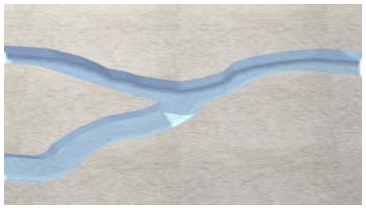
- Typically 155 liters is needed for a watertight concrete mix
- 90 liters is required for the chemical reaction (cement hydration)
- 65 liters is for workability only

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY

Voids that affect the watertightness of Concrete:

- Capillary Voids, size < 1.3um quantity (theoretically 0% up to > 30%)
  - Results from water which is not used for hydration
  - Negative influences watertightness of concrete
  - Quantity depends “only” on w/c ratio
- Compaction Voids, size 0.05 – 10mm
  - Quantity depends on handling of concrete
  - Result of insufficient (wrong) compaction
  - Strongly negative influences watertightness of concrete

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY

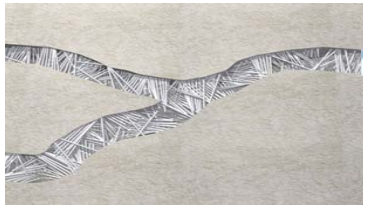


Capillarity

Capillary voids also allow other water soluble chemicals passage:

- Chlorides
- Sulphates
- …..

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONCRETE TECHNOLOGY



Creating Watertight Concrete

- Improve the quality of the concrete
  - Reduce the volume and continuity of the capillary pores (mix design/superplasticiser)
- Block the remaining capillary pore to acceptable level
  - Inclusion of admixtures to block the remaining capillary pores

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SUMMARY OF TEST METHODS

Required test method and limits for Sika® Watertight Concrete

Test Method	Standard	Sika® Limit
Water penetration depth	EN12390-8	< 30 mm
Water conductivity	SIA 262/1 Annex A	< 6 g/m^2 x hour
Drying shrinkage	SIA 262/1 Annex F	< 0.05%

SIKA WATERTIGHT CONCRETE CONSTRUCTION
TESTING METHODS

Water Penetration

- Water penetration under hydrostatic pressure the water permeability limit for watertightness is defined as a maximum water penetration into the concrete under a specific pressure over a defined period
- Water penetration under hydrostatic pressure (according to EN 12390 – 8: 72 hours with 5 bar

SIKA WATERTIGHT CONCRETE CONSTRUCTION
TESTING METHODS

Control / Blank

Water penetration under hydrostatic pressure (according to EN 12390 – 8: 72 hours with 5 bar

Sika® WT

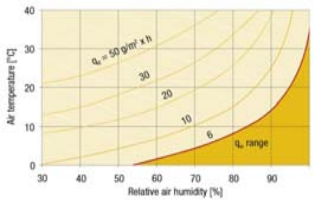
Water penetration under hydrostatic pressure (according to EN 12390 – 8: 72 hours with 5 bar

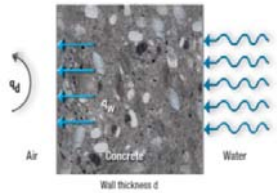
SIKA WATERTIGHT CONCRETE CONSTRUCTION TESTING METHODS

Water Conductivity

- Water conductivity of wet concrete surfaces the water permeability limit for watertightness is defined as g/m2 x h, where water permeability is smaller than vapour volume of water without pressure over a defined period
- Water conductivity (SIA 262/1)

SIKA WATERTIGHT CONCRETE CONSTRUCTION TESTING METHODS





Water Conductivity – Sika Defined Limit

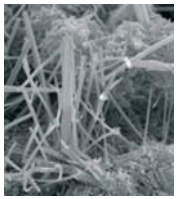
- Water conductivity (SIA 262/1)
- **Maximum 6g/m² x hour**
  (Limit shown by red line)

SIKA WATERTIGHT CONCRETE CONSTRUCTION TESTING METHODS

Drying Shrinkage – Sika Defined Limit

- Drying Shrinkage (SIA 262/1)
- Shrinkage is caused by the slow drying of hardened concrete
- **Maximum <0.05%**
  - Supports reduced shrinkage of concrete

SIKA WATERTIGHT CONCRETE CONSTRUCTION SIKA SOLUTIONS FOR WATERTIGHT CONCRETE



Sika® WT-200 Series

- Based on crystalline technology (self healing)
- Non-soluble crystalline structure formation in the capillaries

Sika® ViscoCrete®
Sika® ViscoFlow®

- Effective water reduction- production of high quality durable concrete
- Ensured workability on construction site

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SIKA SOLUTIONS FOR WATERTIGHT CONCRETE




Sika® WT-200 Series

- Crystalline pore blocker
- Based on crystalline technology (self healing)
- Consists of specially selected chemicals and silica sand

- Crystalline chemicals react when in the presence of calcium hydroxide CaOH (and other hydration by-products) and **moisture**

- Crystalline structure forms and fills and blocks the capillary structure, small voids and micro-cracks
- Lack of **moisture** will stop the reaction (reactivation if re-wetted)

- High performance when water exposure is consistent

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SIKA SOLUTIONS FOR WATERTIGHT CONCRETE




3 Days

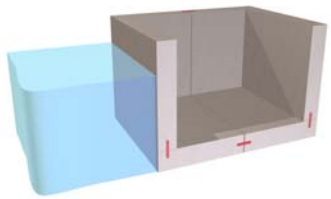
1.8x magnification
Crack width 0.4-0.5mm
Laboratory Conditions

5 Days

9 Days

13 Days

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SIKA WATERSTOP SOLUTIONS

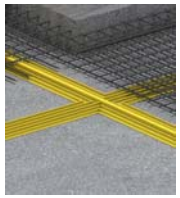


Definition of Joint

A joint is defined as the place in a concrete structure where two concrete sections meet (weakness)

- Construction Joints (non movement)
- Movement Joints

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SIKA WATERSTOP SOLUTIONS

Sika® Waterbar A-19
Sika® Waterbar A-24
Sika® Waterbar D-19
Sika® Waterbar D-24

- Internally placed PVC waterstops

Sika® Waterbar AF-24
Sika® Waterbar DF-24

- Externally placed PVC waterstop

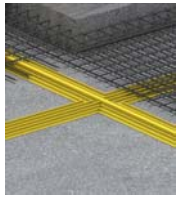
SikaSwell® A 2010
SikaSwell® A 2005
SikaSwell® S2

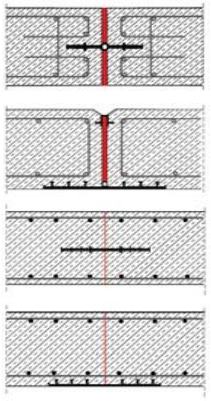
- Internally placed hydrophilic waterstop
- Construction joints
- Service penetrations

SikaFuko® Eco-1
SikaFuko® VT-1

- Internally placed injection hoses waterstop
- Injectable and re-injectable
- Optional for Basic Range

SIKA WATERTIGHT CONCRETE CONSTRUCTION
SIKA WATERSTOP SOLUTIONS





Sika® Waterbar A-19
Sika® Waterbar A-24
Sika® Waterbar D-19
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- Internally placed PVC waterstops

Sika® Waterbar AF-24
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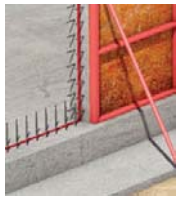
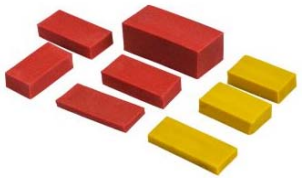
- Externally placed PVC waterstop

SIKA WATERTIGHT CONCRETE CONSTRUCTION
CONSTRUCTION JOINTS (NON-MOVEMENT)



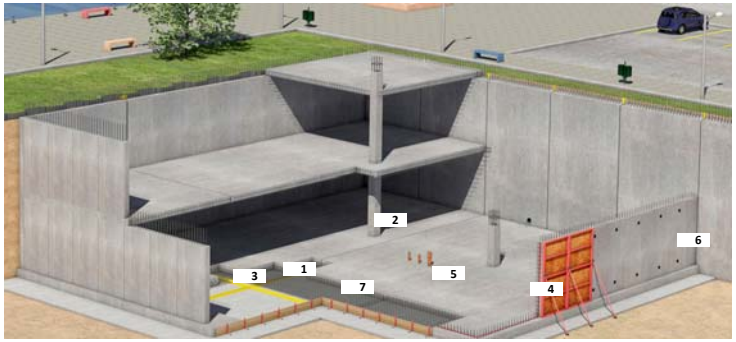


SikaSwell® A 2010
SikaSwell® A 2005
SikaSwell® S2

- Internally placed hydrophilic waterstop
- Construction joints only
- Service penetrations
- Use in combination with SikaSwell® S2

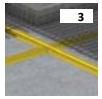
CONSTRUCTION JOINTS (NON-MOVEMENTS)

Type	Width (mm)	Thickness (mm)	Cross section
2005	20	5	
2010	20	10	
2015	20	15	
2025	25	20	



Sika®WT
Watertight Concrete Minimum thickness ≥ 200mm
Pour dimensions to not exceed guidance

Sika® ViscoCrete®
Water reduction and improved durability



Sika®Waterbar
Movement and construction joints

SikaSwell®
Construction joints

SikaSwell®
Sealing services and penetrations

SikaSwell® A-Rings and Plugs
Sikadur®31
Sealing tie bar holes

Design
Maximum single crack width design ≤ 0.3mm

SUMMARY OF MIX DESIGN RECOMMENDATIONS

Components	Comments	Specification
Aggregate	- Balanced particle- size distribution curve required - Clean and compliant to local standard - Recycled aggregate should not be used	- Maximum size of approximately 32mm
Cement	- Compliant with local standards	- Minimum binder content 350kg/m^3
Secondary Cement Material (SCM)	- Fly ash and ground granulated blast furnace slag only	- Maximum 40 % of total binder content
Water	- Fresh water and recycled water with requirement regarding fines. Water cement ratio according to local standards for exposure class	- Maximum 0.45
Concrete Admixtures	- Type dependent to ensure water cement ratio, initial flow workability over time	- Sika® ViscoCrete® / Sika® ViscoFlow® 0.60 – 1.50 %
	- Sika® WT to ensure watertightness	- Sika® WT 1.00 – 2.00 %

SUMMARY OF DESIGN AND CONSTRUCTION GUIDANCE

Components	Guidance
Design	- Restrained shrinkage and thermal movement. Crack formation to a maximum single crack width ≤ 0.3mm
Concrete Thickness	- Sika Watertight Concrete should a minimum thickness of 200mm
Site Preparation	- The site should be level and a separation membrane should be applied
Concrete Pours	- Maximum pour dimension aspect ratio should not exceed 3:1 - Watertight wall = maximum 25 m^2 - Watertight slabs maximum 100 m^2
Formwork Installation	- Well constructed - Joints to be grout tight (grout loss/honeycombing)
Concrete Curing	- Curing should take place at the earliest opportunity

SUMMARY OF TEST METHOD AND LIMITS

Required test method and limits for Sika Watertight Concrete

Test Method	Standard	Sika Limit
Water penetration depth	EN12390-8	< 30 mm
Water conductivity	SIA 262/1 Annex A	< 6 g/m^2 x hour
Drying shrinkage	SIA 262/1 Annex F	< 0.05%

LINCOLN MEMORIAL POOL, WASHINGTON D.C. USA

SIKA WATERTIGHT CONCRETE

Project Description

The old reflecting pool, completed in 1924 and demolished in 2009, held 6.75 million gallons of water, much of which evaporated or continually leaked from the pool and which was replenished with more than 30 million gallons of city potable water annually.

Requirements

A concrete mix design was required to meet all the project specifications for durability, shrinkage and watertightness. To ensure the watertightness of the entire project, a cost effective and efficient joint sealing system was also needed.

THANK YOU FOR YOUR ATTENTION

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