PUDLO: Waterproof concrete. Watertight guarantee.

The **PUDLO** System provides the highest standard available of watertightness, hydrostatic pressure resistance, and ease of construction. With an unrivalled global record of product performance in service spanning 130 years, the **PUDLO** system has been continually specified where watertightness and corrosion resistance is critical, and moisture leakage is not an option.

Contents

Introduction

PUDLO is the world's most widely used concrete waterproofing system.

From iconic desert towers and flagship waterside developments, to hospitals and homes, **PUDLO** admixture adapts concrete to meet tough performance criteria in challenging environments.

Its commercial launch more than 130 years ago pioneered a dynamic engineering concept: integrally waterproof concrete. Decades of problem-free service from landmark buildings and vital infrastructure around the world are a telling testament to **PUDLO'S** integrity.

PUDLO: CHANGING PERCEPTIONS OF WHAT CONCRETE CAN DO

Today, as part of the David Ball Group, **PUDLO** continues to lead the field in concrete protection.

The science is empowering. Architects and engineers have licence to design water-resistant (and water-retaining) structures fully compliant with codes and standards, and uncomplicated by the time, cost and vulnerability of external membranes.

But **PUDLO** goes further. It provides overarching protection for the construction team, client, investor and building user with an unparallelled assurance: an industry-leading guarantee of structural performance.

Much more than a product, **PUDLO** is a partnering scheme. Product application is backed by technical consultation and quality inspection, from design concept to building handover.

PUDLO reduces the project team's risk, inspiring 'outside the box' engineering in concrete that remains within safe, commercially underwritten bounds. More than a waterproofing admixture, **PUDLO** safeguards business reputations and design legacies - true empowerment for today's building professional.

PUDLO was used to waterproof the 30 metre double basement in the canal-side development of Merchant Square in London's Paddington Basin. Ensuring long-term, problem-free performance from the waterproofing specification was critical to the team responsible for design and construction.

PUDLO: totally waterproof ▸

"The Dubai Fountains represent the smartest example of water engineering in the world. And **PUDLO** is there, right at the heart of the system, to keep the water out."

DAVID BALL, CHAIRMAN, PUDLO

The breathtaking Dubai Fountains rely upon 2.5km of underwater tunnels constructed using **PUDLO** concrete. While the fountains throw 25,000 gallons of water into the air in a single second, **PUDLO** ensures not one drop enters the tunnels beneath them.

At the heart of our system is **PUDLO**

PUDLO is a powdered, non-toxic, odourless admixture which makes concrete completely waterproof. It also increases concrete's strength, provides resistance to corrosion, significantly improves workability, and reduces shrinkage and wetting expansion.

All known corrosive effects on concrete are moisture-driven. **PUDLO** waterproofs concrete and therefore increases its durability by reducing the number and size of capillary pores, inhibiting transport mechanisms for water and water-borne chemicals. **PUDLO** concrete is also acid resistant.

How **PUDLO** protects concrete

Capillary restriction: PUDLO modified concrete has a distinct microstructure characterised by discontinuous pore formation and an overall reduction in the size of the capillary pore network.

Capillary blocking: In addition to altering the microstructure, **PUDLO** contains hydrophobic pore-blocking compounds. These permanently seal remaining voids in the concrete to further increase structural durability, providing an additional level of protection against water migration and corrosive attack.

"**PUDLO** MODIFIED CONCRETE IS MORE EFFECTIVE UNDER CONDITIONS OF HIGH HYDROSTATIC PRESSURE THAN WATER-RESISTING CONCRETES THAT RELY ENTIRELY ON HYDROPHOBIC OR PORE BLOCKING ADMIXTURES ALONE."

MOTT MACDONALD, SPECIAL SERVICES

PUDLO: fast progress, reduced cost

PUDLO was specified on the construction of the new Royal London Hospital. Over 3,000m³ of **PUDLO** modified concrete was poured instead of a membrane system, saving construction time by eliminating a complete contract stage.

WHY **PUDLO**?

Track Record: Unrivalled global record of product performance spanning over 140 years.

Performance gains: Removes the primary mechanisms of corrosion, making concrete not just waterproof, but also stronger and more durable.

Quality: BBA certified, CE marked to BS EN 934-2:2001 and manufactured in the UK under ISO 9001 accredited quality systems + batching plant and on-site QA supervision.

Buildability: PUDLO modified concrete provides integral, membrane-free waterproofing that cannot be physically damaged and will last the lifetime of the structure.

Unmatched guarantee: 20 year warranty of the completed structure, offering far greater commercial value and peace of mind than just a simple product warranty. This is further supported by an independent insurance-backed guarantee.

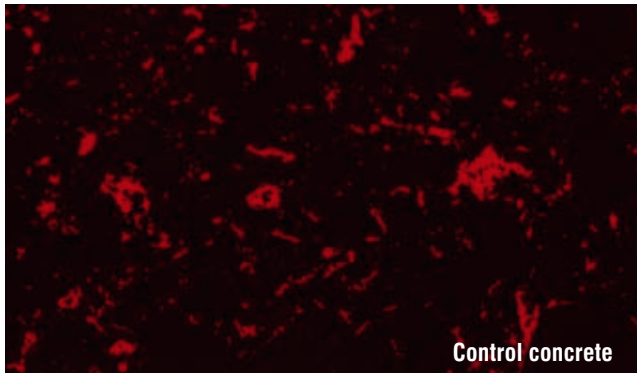
Commercial Advantage: Eliminates a complete subcontract phase of the works, saving material costs and construction time.

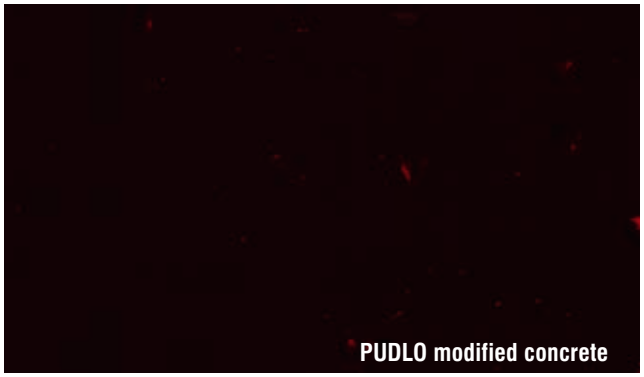
Sustainable: Removes excessive materials and allows a reduction in the amount of Portland Cement while maintaining the original target strength characteristics of the mix design.

Safe: PUDLO is completely non-toxic and raises no known health and safety issues.

PUDLO: tested, proven, trusted

Independent analysis by the Concrete Durability Group at Imperial College London reveals the substantial reduction in water transport mechanisms in **PUDLO** modified concrete.





Microslides showing the reduction in the capillary pour water transport mechanisms as a result of **PUDLO**. Red spaces denote voids.

The control concrete used for testing has a water/cement ratio of 0.45. Even before the addition of **PUDLO**, this control concrete is already more water resistant than some concretes modified with competing admixtures. The addition of **PUDLO** to the control mix results in a five-fold reduction in the water permeability characteristics of an already high quality control concrete.

Microstructural examination carried out by Imperial College revealed that **PUDLO** has a distinct microstructure resulting in a discontinuous pore structure with an order of magnitude reduction in the capillary pore network. The Imperial College's findings are supported by scientific evaluations of **PUDLO** properties by a wide range of independent organisations including:

British Board of Agrément (BBA) ■ BRE ■ Mott MacDonald – Special Services ■ CERAM ■ Taywood Engineering ■ Cemex ■ LSM ■ Al-futtaim Tarmac ■ Al-futtaim Bodycote ■ Fugro Middle East ■ Arab Centre for Engineering Studies.

WATERPROOF • CORROSION-RESISTANT • GUARANTEED

PUDLO makes it possible to build water-retaining structures such as swimming pools, waste-water treatment plants and reservoirs, as well as structures that keep water out - basements, tunnels, underground and underwater facilities. **PUDLO** achieves this without the need for membranes, significantly reducing the time and costs associated with construction.

PUDLO: a better product; a better service

What we make comes in a bag. What we sell doesn't. We make **PUDLO**. **We sell peace of mind.**

"It helps having the best product on the market but **PUDLO'S** ability to deliver on our promise fundamentally reflects the level of support and supervision we offer every customer as standard."

DAVID BALL, CHAIRMAN, PUDLO

◀ **PUDLO:** support at every stage

"**PUDLO** were the only people who came back with ideas for a solution and who were keen to spend time working on a mix that would provide all the performance characteristics we required."

"They provided us with very good up-front technical service in developing and refining a design for the mix. This was followed by further service support inspecting the mix, the batching and attending site to oversee that it was placed and cured correctly."

IAN FLEWITT, PRICE MYERS
ARSENAL WASTE TRANSFER

When you buy **PUDLO** you don't just get the best performing waterproofing additive on the market, you also get Quality Assurance and support from a dedicated team of experts.

PUDLO'S reputation is built on the fact that nothing is left to chance. Every project is inspected by **PUDLO'S** dedicated site support staff. This team exists solely to offer on-site QA support and ensures the highest standards are met at every stage of construction.

PUDLO'S Quality Assurance support comes as standard at no extra cost and includes:

- **Mix Design Approval**
- **RMC/Batching Plant Briefing**
- **Pre-Start Contractor Induction Meeting**
- **Pre-Pour preparation inspection and approval**
- **Pour Attendance – All Pours inspected and documented**
- **Post Pour Curing inspection and approval**
- **Final Completed Works inspection and approval**
- **Issue of 20 year warranty and insurance-backed guarantee (UK only)**

On each and every project, **PUDLO** allocates a Site Inspector responsible for recording all aspects of the preparation, pouring and curing of **PUDLO** modified concrete. It is this commitment to Quality Assurance that enables **PUDLO** to guarantee every inch of the completed works containing **PUDLO** modified concrete.

OUR WARRANTY: 20 YEARS. OUR EXPERIENCE: 130 YEARS.

PUDLO: easier to work with

By incorporating **PUDLO** into the concrete mix, it is possible to build watertight structures, without the need for membranes or drainage systems.

Adding **PUDLO** improves the workability of concrete – making it easier to pour, improving surface finish and reducing shrinkage thus improving dimensional stability.

With an unrivalled global record of product performance in service, **PUDLO** modified concrete has been continually selected where watertightness and corrosion resistance is critical and moisture leakage is not an option.

PUDLO: experience and expertise

"It doesn't matter whether you're working on a celebrated national monument or a small suburban semi. For **PUDLO**, every waterproofing project is a critical project."

CHRIS HOWARD, CEO, PUDLO

Commercial

Royal Albert Hall, London.

PUDLO played a vital waterproofing role in the major extension and refurbishment programme at the Royal Albert Hall, waterproofing a five storey underground car park and services facility underneath one of the UK's most treasured landmarks.

"When you are working on a national monument like the Royal Albert Hall the sense of responsibility becomes more acute. Quality assurance, mix design, and precise delivery and installation of the concrete were all pivotal to a satisfactory conclusion to this job as a whole. We were assured by the presence of the admixture specialist's inspectors during and after the installation."

PETER GORING, TECHNICAL DIRECTOR, JOHN DOYLE CONSTRUCTION

Commercial

Merchant Square, Paddington, London.

The largest commercial building in the Merchant Square development, comprising of a large underground basement and health club on the banks of the Paddington basin.

PUDLO waterproofing was integral to the critical standard of waterproofing required at this mixed-use development.

As well as incorporating some of the largest floorplates in the West End, Building E at Merchant Square used 'top-down' construction.

Architects: Mossessian & Partners
Contractor: Expanded Structures Limited

Commercial

AIG European Headquarters, London.

PUDLO waterproof concrete replaced membranes and reduced the construction schedule which enabled the client to occupy the new headquarters one month earlier than originally expected as well as significantly reducing construction costs.

Consulting Engineers: Mott MacDonald
Contractor: Mowlems

Commercial

HR Wallingford, Oxford.

PUDLO was used in the construction of the purpose-built and environment-controlled hall containing a series of state-of-the-art wave flumes, basins and tanks for the physical modelling of structures and hydraulic features.

Dr Keith Powell, Director of HR Wallingford said: "The integrity of the research carried out in our modelling tanks and flumes relies in part on the integrity of their construction and finish. **PUDLO** admixture has been a key ingredient in achieving the structural performance, water-tightness and constructional accuracy of these critical concrete structures. It will also provide enhanced durability and assure dimensional stability for many years of testing to come."

Contractor: Toureen Mangan

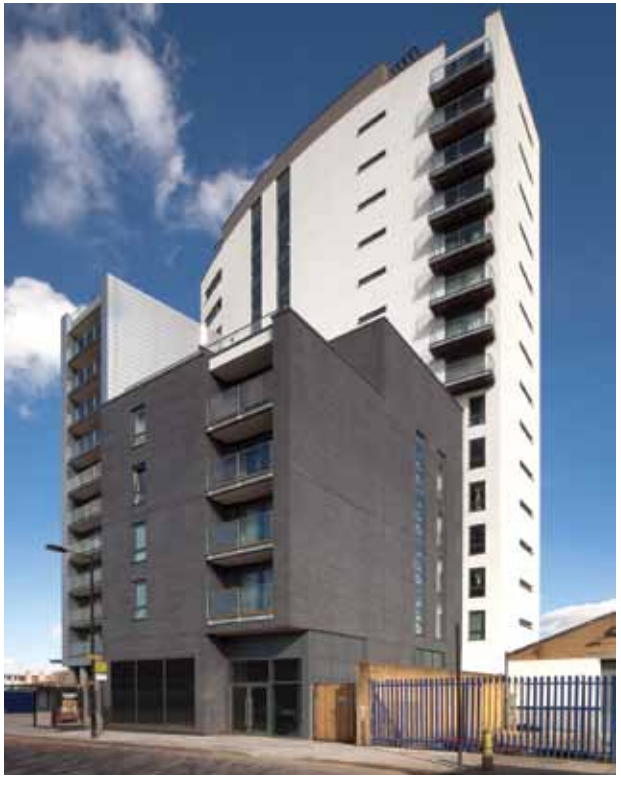
Residential

Digital Media Centre, Leicester.

Mixed-use development with facilities including apartments, office space and media gallery.

Contractor: Willmott Dixon Group

Residential



Vasthouse, London.

High quality mixed-use development spanning more than 15 storeys. The development includes residential apartments and ground floor restaurant and retail units.

Architect: BUJ Architects
Consulting Engineer: Hale Allen Jones
Contractor: Foundation Developments Limited

Residential

Caspian Wharf, London.

PUDLO ensured a watertight finish on this waterside development located on the Limehouse Cut Canal.

Client: Berkeley Group Holdings PLC
Groundworks Contractor: AJ Morrisroe & Sons Ltd

Heathwest, London.

Four large luxury residential houses in London, with large basement car parking and swimming pool constructed using **PUDLO**.

Architect: KSR Architects
Contractor: John Doyle Construction

Retail

Victoria Square, Belfast.

PUDLO modified concrete was the chosen waterproofing solution at the multi-award winning Victoria Square, Belfast.

The scheme included construction of 800,00sq ft of retail space, 116 residential apartments and a leisure zone with cinema, restaurants, bars and cafes.

Consulting Engineer: BDP
Contractor: Farrans (Construction) Ltd

Retail

St David's II, Cardiff.

St David's II is a £675m extension of the original St David's centre and is one of the largest schemes in the UK.

The overall project used over 91,000m^3 of concrete.

Architect: Benoy Architects
Concrete Frame Contractor: PC Harrington Contractors Limited

Bridges & Tunnels

Huntingdon Town Bridge.

PUDLO produced a fine, free-flowing grout to match the stone of the bridge, which was suitable for above and underwater conditions. English Heritage's criteria were satisfied by meeting aesthetic requirements and keeping the bridge open to traffic.

Contractor: John Martin Construction

Green Park Station Tunnel.

The purpose of the project at Green Park was to provide the station with step-free access between street level and all operational platforms via the enlarged ticket hall. The station, used by an estimated 25 million people annually, is now accessible for Tube passengers with disabilities and passengers with reduced mobility.

Contractor: Joseph Gallagher Limited

Bridges & Tunnels

M40 Bridge, Longbridge.

PUDLO concrete was used to meet the durability requirements of precast concrete used in reinforced earth bridge abutments and retaining walls.

Client: Highways Agency
Designer: Hyder Consulting
Precast Contractor: Reinforced Earth Company Ltd

High Exposure

The Dubai Fountains, UAE.

The world's largest dancing fountains required over 25,000m^3 of **PUDLO** modified concrete in the construction of underground tunnels measuring 2.5km beneath the 32 acre attraction. The interconnected tunnels contain critical fountain operating equipment as well as the control room.

Client: Emaar Properties PJSC
Consulting Engineers: Hyder Consulting, M.E Ltd & Turner International

High Exposure

Arsenal Waste Transfer Station, London.

Three-storey £60m facility provided a multi-purpose waste transfer and recycling hub for North London Waste Authority.

PUDLO worked with the complete project team and carried out various testing at microstructure level to ensure the product was suitable for this highly corrosive environment. The tests showed a significant increase in abrasion resistance over ordinary C40 concrete.

Consulting Engineer: Price & Myers
Contractor: Sir Robert McAlpine

High Exposure

The Yas Hotel, Abu Dhabi.

The flagship five star hotel set half on land, half on water, is positioned at the heart of the Formula One Yas Marina Circuit.

Over 20,000m^3 of **PUDLO** modified concrete was used in the underground tunnels and basement to ensure this prestigious project is kept watertight.

Client: Aldar Properties

Leisure

Park Plaza Hotel, London.

This £300m contemporary hotel is situated in central London with views of the Houses of Parliament, The hotel has more than 15 storeys and 1,000 guest rooms.

Architect: BUJ Architects
Contractor: WW Gear Construction Limited

The City Inn Hotel, Westminster.

This hotel development has over 580 guest rooms and various conference facilities.

The main structure of the hotel is in keeping with the surrounding buildings both in terms of height and materials but the trademark Skylounge is treated as an identifiable element on the roof which will sit above the roofs of the adjacent buildings while not hindering the established skyline.

Consulting Engineer: Buro Happold & Faber Maunsell

Leisure

Newmarket Leisure Centre, Suffolk.

Comprised of a state-of-the-art, six-lane 25 metre competition pool and a flexible use training pool with a movable floor to adjust water depth. **PUDLO** was used to waterproof the concrete design for all the water-retaining and below-ground structures, including the two pools, balancing tanks and basement plant room.

"We were given a complete service, on and off-site."

MATTHEW NEWTON, SENIOR ENGINEER WSP

Leisure

Fulham Pools, London.

Fulham Pools leisure centre contains a 25 metre eight-lane competition pool with a viewing gallery for approximately 250 people, a 25 metre six-lane fitness pool and a teaching pool .

"An important factor in our decision to use **PUDLO** for the critical waterproofing elements of the contract was the warranty they were prepared to offer."

PAUL FREEMAN, AMEC PROJECT MANAGER

Education

The City Academy, London.

The Academy, costing £30m opened in 2009 in Hackney, London and is an inspirational educational facility, employing a thoroughly integrated sustainable environmental strategy.

The building, which achieved BREEAM Very Good, is 25% more efficient than building regulation requirements and received an A-rating Energy Performance Certificate. The City Academy in Hackney has won several sustainable development awards including:

- **Best New Build Project at Chartered Institution of Building Services Engineers' Awards 2010**
- **Low Carbon Performance Awards 2010**
- **London Constructing Excellence Award 2010 for Collaborative Working.**

Main Contractor: Willmott Dixon Group
Groundworks Contractor: Toureen Mangan

Education

INTO Newcastle University.

INTO Newcastle is a collaboration between Newcastle University and INTO Partnerships to provide an exciting new overseas student teaching facility.

The complex features two new halls of residence and the brand new four-floored Academic Building.

It caters for around 700 students and includes a cafe, specially designed language and science labs, a lecture theatre, and offices for administration and teaching staff. Providing more than 32,000 square ft of teaching space, it is INTO's biggest centre yet.

Architect: ARUP
Groundworks Contractor: McGee Construction

Education

Middlesex University, London.

The new £80m Art, Design and Media campus accommodates more than 1,600 students. The Greater London Authority has described it as 'world class design'.

Architects: BPR Architects
Contractor: Galldriss Construction Limited

Hospitals

Royal London Hospital, London.

Britain's largest new hospital, which includes one of Europe's largest renal units. More than 3,000m^3 of **PUDLO** modified concrete was used in the construction.

Structural Engineers: Halcrow Yolles
Contractor: Skanska

Hospitals

Finchley Memorial Hospital, London.

The £40m Finchley Memorial Hospital and Walk-in Centre for minor injuries opened in 2012.

The new site sees NHS Barnet working with GPs to commission services including specialist rehabilitation and intermediate care, GP services, outpatients, therapies, X-ray, pharmacy and an infusion suite.

Main Contractor: Galliford Try PLC
Groundworks Contractor: Ground Construction Limited

Addenbrookes Hospital, Cambridge.

In 1962 **PUDLO** was used to waterproof the 1.6km of underground tunnels.

Consulting Engineers: ARUP

Hospitals

Pembury Hospital, Kent.

The £225m PFI hospital was undertaken for the Maidstone and Tunbridge Wells NHS Trust by the Equion Consortium and contractor Laing O'Rourke. It brings together Pembury Hospital and the Kent and Sussex Hospital into a 66,000m^2 seven-storey redevelopment on the existing Pembury site near Tunbridge Wells. Construction commenced in 2008, and the hospital was fully operational by 2012.

More than 5,000m^3 of **PUDLO** modified concrete was used in the basement slab and walls, retaining walls, cores, lift walls and the car park slab.

Architects: Anshen + Allen
Consulting Engineers: Gifford
Contractors: Expanded Structures Ltd

PUDLO concrete expertise: concrete advantages over membrane

PUDLO has pioneered the advantages of membrane-free waterproofing for more than a century.

Membranes have been regarded as the 'traditional' way of protecting concrete in buildings from leaks and water damage. However they have limitations;

- **Expensive and vulnerable to the risk of mechanical damage during the construction process.**
- **Time consuming and labour intensive to install, particularly for temporary works and penetrations.**
- **They require complex detailing, jointing and demand the highest standard of workmanship and skill in order to be successful.**
- **They prevent the natural autogenous healing (now known to be a mechanical self sealing process) and encourage drying shrinkage cracks. (IStructE 2004 Guide to Deep Basement Construction)**
- **Leaks caused by defects in external membranes are practically impossible to locate and repair, since the water invariably enters the structure through cracks or other vulnerable points, such as movement joints, at some distance from external defect. Therefore it is difficult if not impossible to have good leak-source identification.**

Using PUDLO modified waterproof concrete has the following advantages:

- **A single point of responsibility for Waterproofing, in line with the recommendations of "ICE Reducing the Risk of Leaking Substructure – A Clients Guide 2009".**
- **Reduced design costs since the concrete is the membrane and will be poured anyway.**
- **Structurally integral waterproof concrete is maintenance-free, cannot be damaged and will last for the lifetime of the structure.**
- **Project programme savings as a result of the removal of a complete sub-contract.**
- **PUDLO offers a more sustainable solution achieving a lower project carbon footprint.**
- **Full service solution providing guaranteed protection on the completed works.**
- **In the unlikely event of a leak the source of the problem is readily identifiable and easily fixed.**

"The concrete is in itself the waterproof membrane."

STEVEN BRUNSWICK
TECHNICAL SERVICES DIRECTOR, MOWLEM

AIG European Headquarters

The two storey basement had to meet the highest possible specification for waterproofing as it was to be used for document storage. The original designs involved a membrane system but recognising the inherent advantages of waterproof concrete Duffy Construction recommended **PUDLO**.

Had a membrane system been used there would have been the potential for leaks around each pile head. The **PUDLO** system eradicated this risk. It also avoided other problems that can arise with membrane systems around wall and slab joints and other overlapping areas.

"The decision to use **PUDLO** over a membrane system allowed an entire month to be taken out of the construction programme on the AIG build. This represented a significant saving on the project."

STEVEN BRUNSWICK
TECHNICAL SERVICES DIRECTOR, MOWLEM

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PUDLO is a division of the David Ball Group PLC.