Belfast Sewers Project: Terminal Pumping Station

The PUDLO cwp System offers the opportunity for the highest standard available of watertightness, hydrostatic pressure resistance, and ease of construction, coupled with a completed project based warranty for the completed structure.

With an unrivalled global record of product performance in service spanning 100 years, PUDLO modified concrete has been continually selected where watertightness and corrosion resistance is critical, and moisture leakage is not an option. (Please see Enclosure 1 for our Project sample list (1920 onwards).

David Ball Group have the experience gained in construction projects across ground conditions ranging from the high exposure class environments of deep basement membrane free construction in Dubai, to the unique nature of the soft estuarine quasi-thixotropic deposits that underlie both banks of the River Lagan in Belfast – sleech. (Please see Enclosure 2 for specific projects illustrating water tightness, build ability and commercial advantage.)

The use of PUDLO modified concrete offers the following unique advantages:

**Watertight Construction**, ultra low permeable concrete with proven global performance in service.

**Dimensional Stability** over conventional concrete, significantly reduced shrinkage and wetting expansion.

**Strength Gain**, typically an increase of over 20% to a C35/40 mix.

**Corrosion Resistance**, a 100% increase in chloride resistance, a reduces the rate of carbonation by a factor of 4

**Improved Workability & Pumpability**, PUDLO significantly improves the concrete quality for ease of placing and finishing.

**Buildability**, The concrete is the membrane, which cannot be physically damaged, will not deteriorate and will last the lifetime of the structure.

**Commercial**, allows the removal of a complete subcontract phase of the works, thus saving material costs and construction time.

**Quality, On site Attendance**, as part of our warranty process David Ball Group attend the batching plant and all concrete pours to ensure the materials are produced and placed in accordance with good practice and specifically conforms to our User Guide. In this way we can offer unmatched Warranty and Customer Protection, peace of mind to Contractors, Consulting Engineers, Architects and Clients over the design life of the structure.
THE COMPANY

David Ball Group is the leader in its field as manufacturer and specialist supplier of the world's first and technically most advanced concrete treatment for the production of watertight, corrosion-resistant concrete structures - PUDLO.

With over 100 years of continuous successful use all over the world, PUDLO offers an unrivalled record of product performance in service.

PUDLO is the world's first and most widely used admixture for producing Watertight, Corrosion-Resistant Concrete.

PUDLO has a time-proven, unrivalled track record of successful use, spanning over 100 years all over the world.

Manufactured exclusively under ISO 9001 accredited quality systems at our factories in Bar Hill near Cambridge, PUDLO eliminates the need for external membranes, thereby saving materials and construction program costs.

David Ball Group is also widely regarded as the worldwide market leader in the supply of ultra- high-quality Standard Reference Materials - David Ball Specialist Sands.

For more than 35 years the company has been exporting its unique ultra-high-quality industrial sands around the world for cement testing, electric fuse filling, man made fibre production, water filtration, and all areas where consistency and quality of product are paramount.

Being BS EN ISO 9001 and CE Marked to BS EN 934-2:2001 accredited David Ball Group recognise that quality and product consistency is paramount in our customers purchasing decisions. Please see Enclosure 3 for a copy of our certificates.

As market leading product developers the David Ball Group David Ball InstaRange represents a comprehensive group of cementitious products to complement its world leading PUDLO brand.
EARLY HISTORY OF PUDLO

Since Tudor times clay has been puddled to enable river banks and earthworks to remain watertight. From this verb comes the generic trade mark Pudlo. Pudlo is the world's first integral waterproofing admixture for use with concrete and mortar. Pudlo has been in continuous use since Victorian times for waterproofing both steel reinforced and non-reinforced concrete.

Henry Faija an engineer and an authority on Portland cement, had by 1875 set up a Portland cement testing laboratory in the UK. This facility, which was quoted in a number of early Pudlo technical reports was operational until at least 1890 and carried out a series of tests on Pudlo. Faija died at the early age of 49 in 1894 and the "the long term effects of the use of Pudlo" to which he referred relates to Pudlo modified concrete produced around 1880.

WORLD WIDE USE

During the next 40 years Pudlo modified concrete appeared in major government approved construction projects in, for example, Japan, Canada, Spain and the Netherlands. Included was a large cement works which was 'Pudlo-ed' below ground. Product testing was maintained by David Kirkaldy & Son in the 1930's and by various academic institutions including Cork University, Ireland.

Custom for the product was such that by 1920 the Instructions or Directions for use were translated into, for example, Arabic, Chinese, Russian, Greek, Japanese, Hungarian. Leading journals including The Builder, Specification, Building Trades Journal, etc. carried advertising literature citing examples of use, which include, sewerage treatment works, the Bell Telephone H.Q., and a 5 million gallon reservoir.

In 1992 David Ball Group plc. established in quality sands and cements acquired the company Kerner-Greenwood of Kings Lynn, Norfolk, the manufacturers of Pudlo.

David Ball Group plc commissioned independent research within the Department of Civil Engineering Imperial College London, on the effect of generic materials and admixtures on the durability, performance, pore size characteristics and microstructural properties of concrete.
PERFORMANCE

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

PUDLO reduces corrosion mechanisms within concrete and as a result, increases structural durability. The system is suitable for use in aggressive and hostile conditions such as coastal defence areas and waste-transfer sites. PUDLO has been used successfully worldwide to provide protection against water ingress and corrosion, even in high exposure class environments.

Comparison between control concrete and PUDLO modified concrete

![Control Concrete](image1)
![PUDLO modified concrete](image2)

The benefits of watertight concrete - reducing the passage of water within concrete will reduce the primary corrosion mechanism. Porosity Highlighted in red scale.

- Single Dry powder product provides a multipurpose solution
- Non-toxic powder and has no health and safety problems e.g., No ammonia gas and no alkaline aggregate risk
- Removes a complete sub-contract phase
- Reduces project material cost
- Improve chloride resistance by 100%
- Reduce rate of carbonation by a factor of 4
- Increase strength by minimum of 10%
- Significantly reduced shrinkage and zero wetting expansion leading to exceptional dimensional stability
- The structure cannot be damaged once cast and produces more durable structures

PUDLO is a hydrophobic and pore blocking admixture which alters the microstructure of concrete to stop water transport mechanisms and increase durability
### FEATURES

- A single product, multipurpose solution
- Batching Plant attendance, and on site attendance and advice for all PUDLO modified concrete pours.
- **PUDLO** is supplied with a 30 year company warranty that covers not only the product but also covers the completed section of works containing the waterproofed concrete against ingress of moisture.
- Transport and storage is straightforward, as a powder **PUDLO** can be stored in dry conditions indefinitely, so well ordered supply chain.
- Supplied in 8kg water soluble bags for ease of batching (8kgs per m³ of concrete)
- No smell or any other Health & Safety implications (does not contain OPC)

Please see Enclosure 4 for the PUDLO CWP Technical Data Sheet, Health and Safety Sheet and PUDLO User Guide.
<table>
<thead>
<tr>
<th>PERFORMANCE</th>
<th>FEATURES</th>
<th>BENEFITS</th>
</tr>
</thead>
</table>

**TRACK RECORD**

Using **PUDLO** modified concrete carries with it the peace of mind of using a product with over 100 years of proven global service.

**DURABILITY**

**PUDLO** reduces the primary corrosion mechanisms within concrete and as a result, increases structural durability.

**QUALITY**

BBA approved (please see Enclosure 5) and CE marked to BS EN 934-2:2001, manufactured in the UK under ISO 9001 accredited quality systems, supplied inclusive of batching plant and on site attendance complete with a 30 Year Warranty covering the completed works.

**PERFORMANCE**

The concrete is the membrane, which cannot be physically damaged, will not deteriorate and will last the lifetime of the structure.

By eliminating the need for external waterproofing membranes, the use of **PUDLO** modified concrete saves construction time, and materials costs.

**GUARANTEE AND CUSTOMER PROTECTION**

30 year Warranty on the completed works, not just a product warranty.

Additional premium based Independent Insurance guarantee available.
30 YEAR DAVID BALL GROUP WARRANTY

The performance characteristics and unrivalled continuous service record of PUDLO spanning over 100 years, is reflected in the industry leading warranty and guarantee provision that David Ball Group offer.

The policy of batching plant, on site recording and concrete pour attendance ensures that our clients enjoy unmatched guarantee and customer protection, with peace of mind for Contractors, Engineers, and Architects.

PUDLO is supplied with a 30 year company warranty (please see enclosure 6) that covers not only the product but also covers the completed section of works containing the waterproofed concrete against ingress of moisture.

In addition to the manufacturers warranty, the option of an independent insurance backed premium based guarantee is also available. Please see Enclosure 7 for further information.

INDEPENDENT INSURANCE GUARANTEE

Key Features

- 10 year non-cancellable cover (renewable by inspection)
- Cover for defects due to faulty design, specification, workmanship or materials
- Available for new, recently constructed, partially completed and completed commercial and industrial buildings. Also for domestic extensions and conversions
- Insurers pay if physical damage occurs - there is no need to prove fault or resort to litigation
- Cover is freely assignable to any party with a financial interest
- Index linking of sum insured
- One-off single premium
Case Studies

Waterproofed concrete, membrane free construction for deep structures, 5 storey basement.

Watertight, Corrosion Resistant Solution to pedestrian tunnel under Thames

Waterproofed membrane free construction of high strength concrete - former marshland - heavy machinery and underground workshops.

One month off construction schedule and basement is protected to Grade 4.

Please see enclosure 8 for the above case studies and further case studies.
Overview

Technically Superior Product
An unmatched global record of product performance in service spanning 100 years.

Value Advantage
Commercial benefit in reduced construction times and material costs.

Unique Service Provision
Customers buy a service not a product. Pre-Contract advice, on-site attendance and support.

Unmatched Guarantee and Customer Protection
Peace of mind to Contractors, Consulting Engineers, Architects and Clients. We give a 30 year company warranty and optional 10 year (renewable every 10 years of the structure) insurance guarantee.

Unique proposition of David Ball Group plc is being able to;

- Produce watertight concrete with a factor of 5 reduction in water permability than the control (eg, 40/20 mpa).
- ISA Test
  Initial Surface Absorption when measured to BS 1881 is 0 or more accurately, “was too low to measure”.
- Chloride resistant – a reduction of a factor of 5 in chloride ion migration over similar control (plain) concrete.
- Increase of up to 30% of compressive strength of similar control concrete
- Carbonation
  Significant reduction to a factor of 4 in the rate of carbonation.
- No other admixture can achieve these significant durability enhancements
- Expert advice and on-site assistance throughout the project to ensure correct installation and trouble-free construction
Enclosures
Enclosure 1

PUDLO Project List
PUDLO has been used as an integral concrete waterproofer for over a century, throughout the world, on projects ranging from deep basement construction to tunnels to environments such as marine and sewerage effluent.

The following list is a selection of some of the projects, successfully completed using PUDLO.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>DATE</th>
<th>PROJECT DETAILS AND MATERIALS</th>
<th>DESIGNER/ CONTRACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reptile House, London Zoo</td>
<td>1927</td>
<td><strong>PUDLO CWP</strong> Deep basement construction Membrane Free</td>
<td>Mr. E. Guy Dawber</td>
</tr>
<tr>
<td>Bell Telephone Company</td>
<td>1929</td>
<td><strong>PUDLO CWP</strong> Multi-storey complex with deep basements - Membrane Free</td>
<td>Fuller Company of Canada</td>
</tr>
<tr>
<td>Montreal, Canada</td>
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<tr>
<td>Aldred Building Canada</td>
<td>1932</td>
<td><strong>PUDLO CWP</strong> Deep basement construction Membrane Free</td>
<td>Barcott Construction Blackader Consultants</td>
</tr>
<tr>
<td>Waste Water Treatment Works</td>
<td>1933</td>
<td><strong>PUDLO CWP</strong> Underground holding tanks Membrane Free</td>
<td>Vanstone Consulting Engineers, Farr &amp; Lo London</td>
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<tr>
<td>Devon, UK</td>
<td></td>
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<tr>
<td>RC Service Reservoir</td>
<td>1934</td>
<td><strong>PUDLO CWP</strong> 2 million gallon capacity Membrane Free</td>
<td>Government Engineers Hastings Borough Council</td>
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<tr>
<td>Sussex, UK</td>
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<tr>
<td>Sewerage tunnel outlet</td>
<td>1936</td>
<td><strong>PUDLO CWP</strong> Tunnel 40m below ground, 3m diameter Membrane Free</td>
<td>Government Engineers</td>
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<tr>
<td>Liverpool, UK</td>
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<td>City of Westminster Apartment</td>
<td>1945</td>
<td><strong>PUDLO CWP</strong> Deep basement construction Membrane Free</td>
<td>Ashley Newman Co. Ltd Monk &amp; Company</td>
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<td>Complex</td>
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<tr>
<td>London, UK</td>
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<td>Department Store</td>
<td>1946</td>
<td><strong>PUDLO CWP</strong> Basement 3000m3 concrete Membrane Free</td>
<td>Ross McDonald Thompson Yeats</td>
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<tr>
<td>Toronto, Canada</td>
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<tr>
<td>RC Cement storage silos</td>
<td>1950</td>
<td><strong>PUDLO CWP</strong> Underground hopper built below ground</td>
<td>Mautitius Portland Cement Co. Ltd</td>
</tr>
<tr>
<td>Mauritius</td>
<td></td>
<td></td>
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<tr>
<td>Project Description</td>
<td>Year</td>
<td>Details</td>
<td>Contractors/Authorities</td>
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<td>---------------------------------------------</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Colne Valley, Waste Water</td>
<td>1951</td>
<td>PUDLO CWP 14 no. 30m diameter RC holding tanks Membrane Free</td>
<td>Thames Valley Water Authority</td>
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<td>Treatment Works</td>
<td></td>
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<td>Rickmansworth, Herts</td>
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<td>London Chamber of Commerce HQ</td>
<td>1953</td>
<td>PUDLO CWP Deep Basement construction Membrane Free</td>
<td>Gunton &amp; Gunton Minter Ltd</td>
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<td>London, UK</td>
<td></td>
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<tr>
<td>Cork, Ireland</td>
<td>1958</td>
<td>PUDLO CWP Due to high water table PUDLO CWP was used in all ground</td>
<td>Ove Arup Engineers Kerridge Construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and floor slabs. 3500m2 Membrane Free</td>
<td></td>
</tr>
<tr>
<td>Addenbrookes Hospital</td>
<td>1962</td>
<td>PUDLO CWP Perhaps it’s not well known that Cambridge is at sea level.</td>
<td>Lancashire Rivers Board</td>
</tr>
<tr>
<td>Cambridge, UK</td>
<td></td>
<td>So it was the essential that when constructed the 1.6 km tunnel at the</td>
<td>Fairclough Ltd</td>
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<td></td>
<td></td>
<td>hospital was comprehensively waterproofed PUDLO CWP was selected for</td>
<td>Mr. Pot Architect</td>
</tr>
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<td></td>
<td></td>
<td>that purpose. Membrane Free</td>
<td></td>
</tr>
<tr>
<td>RC Defence walls</td>
<td>1964</td>
<td>PUDLO CWP Testimony to the long term effectiveness of PUDLO CWP in</td>
<td>Lancashire Rivers Board</td>
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<tr>
<td>UK</td>
<td></td>
<td>harsh marine environments Membrane Free</td>
<td></td>
</tr>
<tr>
<td>M6 Motor Way</td>
<td>1965</td>
<td>PUDLO CWP Bridge works and viaduct</td>
<td>Fairclough Ltd</td>
</tr>
<tr>
<td>Lancashire, UK</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Polder Tower</td>
<td>1969</td>
<td>PUDLO CWP Water Tower</td>
<td>Mr. Pot Architect</td>
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<tr>
<td>Emmelford, Holland</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Chek Lap Kok Airport</td>
<td>1997</td>
<td>PUDLO CWP Waterproofing Tanking System Facilities Building over</td>
<td>Gammon Construction</td>
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<tr>
<td>Hong Kong</td>
<td></td>
<td>15,000m2 Membrane Free</td>
<td></td>
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<td>Ko Shan Theatre</td>
<td>1997</td>
<td>PUDLO CWP INSTALASTIC (liquid applied flexible membrane)</td>
<td>Hing Lee Construction</td>
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<td>Hong Kong</td>
<td></td>
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<td>Project Name</td>
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<td>Description</td>
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<tr>
<td>Commercial Development</td>
<td>1997</td>
<td>PUDLO CWP, INSTALASTIC&lt;br&gt;Deep basement construction Membrane Free</td>
<td>Inchcape Building Products</td>
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<tr>
<td>Causeway Bay, Hong Kong</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal Albert Hall</td>
<td>1997</td>
<td>PUDLO CWP&lt;br&gt;5 Storey Underground Car Park&lt;br&gt;The Royal Albert Hall is one of Europe's most significant buildings protecting this heritage from water damage is entrusted to the David Ball Group and PUDLO CWP Membrane Free</td>
<td>BDP Consultants Taylor Woodrow</td>
</tr>
<tr>
<td>London, UK</td>
<td></td>
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<tr>
<td>Levita House</td>
<td>1998</td>
<td>PUDLO CWP&lt;br&gt;Integral waterproofing of rendering system</td>
<td>BDP Consultants</td>
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<td>London, UK</td>
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<tr>
<td>Parker Hannifin HQ</td>
<td>1999</td>
<td>PUDLO CWP, INSTALASTIC, hDR Waterstop&lt;br&gt;Deep basement Construction Membrane Free</td>
<td>AMEC</td>
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<tr>
<td>Hemel Hempstead, UK</td>
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<tr>
<td>Blackfriars Hotel</td>
<td>1999</td>
<td>PUDLO CWP&lt;br&gt;Deep basement construction Membrane Free</td>
<td>Sir Robert McAlpine</td>
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<td>London, England</td>
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<td>Trafalgar Square Hilton Hotel</td>
<td>1999</td>
<td>PUDLO CWP, INSTAFLEX PU 25, hDR Waterstop&lt;br&gt;Deep basement construction 100m³ Membrane Free</td>
<td>Watermans Consultants AMEC</td>
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<td>London, UK</td>
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<td>Burj Al-Arab Hotel</td>
<td>1999</td>
<td>PUDLO CWP&lt;br&gt;36th Floor Swimming Pool</td>
<td>Kvaerner Construction W.S ATKINS &amp; Partners Overseas</td>
</tr>
<tr>
<td>American Manila Cemetery</td>
<td>2000</td>
<td>PUDLO CWP, hDR Waterstop&lt;br&gt;Deep basement construction 1200m³ Membrane Free</td>
<td>Mitchellson</td>
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<tr>
<td>Manila, Philippines</td>
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<td>Woodcocks Hill</td>
<td>2000</td>
<td>PUDLO CWP, hDR Waterstop&lt;br&gt;Deep basement construction 1200m³ Membrane Free</td>
<td>Franklin Associates Woolton construction</td>
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<td>Harefield, UK</td>
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<td>30 Brompton Square</td>
<td>2000</td>
<td>PUDLO SCC, hDR Waterstop&lt;br&gt;Underground Art Gallery Membrane Free</td>
<td>US State Department Core Group</td>
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<td>London, UK</td>
<td></td>
<td></td>
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<tr>
<td>American Manila Cemetery</td>
<td>2000</td>
<td>PUDLO CWP, INSTALASTIC&lt;br&gt;4000 m² of waterproof concrete roof Membrane Free</td>
<td></td>
</tr>
<tr>
<td>Project Location</td>
<td>Year</td>
<td>Product Details</td>
<td>Contractor(s)</td>
</tr>
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<tr>
<td>Crown Estates</td>
<td>2000</td>
<td><strong>PUDLO CWP, hDR Waterstop</strong>&lt;br&gt;Deep basement construction, highly aggressive environment 5000m³ and podium deck Membrane Free</td>
<td>Scanmoor Construction, KMG Partnership</td>
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<td>Campbell Park Development, Milton Keynes</td>
<td>2000</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTALASTIC</strong>&lt;br&gt;3500m³ waterproof concrete Membrane Free</td>
<td>Miller Construction</td>
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<td>Chelsea FC</td>
<td>2000</td>
<td><strong>PUDLO CWP, hDR Waterstop</strong>&lt;br&gt;Swimming Pool and leisure facilities Membrane Free</td>
<td>Multiplex Construction, Duffy Construction</td>
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<tr>
<td>NWDC Offices, Wiltshire, UK</td>
<td>2000</td>
<td><strong>PUDLO CWP, hDR Waterstop</strong>&lt;br&gt;Basement Car Park Membrane Free</td>
<td>Jarvis Construction</td>
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<tr>
<td>Vauxhall Bridge Road, London, UK</td>
<td>2000</td>
<td><strong>PUDLO CWP, hDR Waterstop</strong>&lt;br&gt;Used in precast concrete box culverts Membrane Free</td>
<td>Berkley Group PLC, Mcc Nicholas Construction</td>
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<td>Alexandra Complex, Manila, Philippines</td>
<td>2001</td>
<td><strong>INSTALASTIC</strong>&lt;br&gt;12 Apartment Blocks waterproofed over 12,000m² of liquid applied membrane to balconies</td>
<td>Core Group</td>
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<tr>
<td>AIG HQ, London, UK</td>
<td>2001</td>
<td><strong>PUDLO CWP, hDR Waterstop</strong>&lt;br&gt;Double Basement 2500m³ Membrane Free</td>
<td>Mowlem, Mott McDonald, Duffy Construction</td>
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<td>Fulham Pools, London, UK</td>
<td>2001</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTALASTIC</strong>&lt;br&gt;Olympic Swimming Pool Complex Membrane Free</td>
<td>AMEC Design &amp; Build, Hiretest</td>
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<td>Sandown House, London, UK</td>
<td>2001</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTAPRUF</strong>&lt;br&gt;Underground Car Park and swimming Pool 2500m³ Membrane Free</td>
<td>Botes Building</td>
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<td>Upper Richmond Road, Putney, UK</td>
<td>2001</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTALASTIC</strong>&lt;br&gt;1300m³ Membrane Free</td>
<td>Blyth &amp; Blyth, Donald Halstead Associates</td>
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<td>Camden Wharf, London, UK</td>
<td>2001</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTALASTIC</strong>&lt;br&gt;1600m³ Membrane Free</td>
<td>Tru Construction, Donald Halstead Associates</td>
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<tr>
<td>Project Description</td>
<td>Year</td>
<td>Product Details</td>
<td>Client Information</td>
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<tr>
<td>13a Homefield Road Private Dwelling 600m³ Membrane Free</td>
<td>2001</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Andrew Pattinson Architect, Leander Construction</td>
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<td>La Plage development Deep Basement Construction</td>
<td>2001</td>
<td>PUDLO CWP, hDR Waterstop</td>
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<tr>
<td>The Grove Swimming Pool situated on the 1st floor Membrane Free</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Ascon Construction, Faber Maunsell</td>
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<td>British Aerospace Air Bus Project Deep Basement Construction</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>AMEC Design &amp; Build, Murraywood Construction</td>
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<tr>
<td>The Grove Deep Basement Construction</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Ascon Construction, Faber Maunsell</td>
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<tr>
<td>David Lloyd Centre Over 15,000m²</td>
<td>2002</td>
<td>INSTALASTIC</td>
<td>Dean &amp; Bowes</td>
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<tr>
<td>Wimbledon All England Lawn Tennis Club, Centre Court Membrane Free</td>
<td>2002</td>
<td>PUDLO CWP, INSTALASTIC</td>
<td>Galliford Try Construction, BDP Consultants, Byrne Brothers</td>
</tr>
<tr>
<td>199 Knightsbridge 30m deep basement using 5000m³ of concrete Membrane Free</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop</td>
<td>Multiplex, PC Harrington, WSP Consultants</td>
</tr>
<tr>
<td>Shafto Mews Basement Construction Membrane Free</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Total Construction, Price &amp; Myers</td>
</tr>
<tr>
<td>Arsenal Waste Treatment Plant Over 800m² of modified concrete used in the flooring mix Membrane Free</td>
<td>2002</td>
<td>PUDLO CWP, hDR Waterstop</td>
<td>Sir Robert McAlpine, Byrne Brothers, Price &amp; Myers</td>
</tr>
<tr>
<td>Location</td>
<td>Year</td>
<td>Details</td>
<td>Contractors</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------</td>
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</tbody>
</table>
| Golden Square, London, UK     | 2003 | PUDLO CWP, hDR Waterstop
500m³ of modified concrete used in the basement Membrane Free          | Britin Construction
Campbell Reith Hill              |
| Westminster School, London, UK| 2004 | PUDLO CWP, INSTACEM Render, INSTALASTIC
Modified concrete used for slab and render used on existing Membrane Free
Additional waterproof coating | Price & Myers
Maber Assoc
Euroearthworks                   |
| Buckle Street, London, UK     | 2004 | PUDLO CWP, hDR Waterstop
250m³ basement construction Membrane Free                               | Trigram
Ground Construction             |
| Devonshire Baths, Eastbourne, UK| 2004 | PUDLO CWP
300m³ waterproof concrete used in basement podium slab Membrane Free | Berkeley Homes
Coinford Construction           |
| Riverplace, Manchester, UK    | 2004 | PUDLO CWP, hDR Waterstop, INSTALASTIC
Residential development with basement Membrane Free                      | Kinetic
West Properties
PC Harrington                   |
| Grange Road, Willesden, London, UK | 2004 | PUDLO CWP, hDR Waterstop
Council offices with archive and art storage basement Membrane Free       | Allenbuild
Walsh Associates
APT Partnership                 |
| Lauriston Road, Wimbledon, UK | 2004 | PUDLO CWP
Residential basement with Corus Membrane Free                             | Permanex
Big Basement                     |
| Water Research Facility, Oxford, UK | 2004 | PUDLO CWP
Research tanks Membrane Free                                              | HR Wallingford
Toureen                          |
| Manresa Road, Chelsea, London, UK | 2004 | PUDLO CWP, hDR Waterstop
Luxury residential development with basement Membrane Free               | Michael Barclay Partnership
Multiplex / PC Harrington
RMC                              |
<table>
<thead>
<tr>
<th>Project Location</th>
<th>Year</th>
<th>Description</th>
<th>Contractor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Centre for Medium Weather Forecasting, Reading, UK</td>
<td>2004</td>
<td><strong>PUDLO SCC and CWP</strong> Construction of tunnels and large basement areas <strong>Membrane Free</strong></td>
<td>Joseph Gallagher, Brett Associates</td>
</tr>
<tr>
<td>Great Suffolk Street, London, UK</td>
<td>2004</td>
<td><strong>PUDLO CWP</strong> Construction of basement <strong>Membrane Free</strong></td>
<td>Ridgecrest Construction</td>
</tr>
<tr>
<td>NHS Hospital, Islington, London, UK</td>
<td>2004</td>
<td><strong>PUDLO CWP</strong> All below-ground structures <strong>Membrane Free</strong></td>
<td>Alan Conisbee, Bluestone plc/Toureen</td>
</tr>
<tr>
<td>Sheffield Botanical Gardens, UK</td>
<td>2004</td>
<td><strong>INSTALASTIC</strong> Re-lining old fountains</td>
<td>Brambledown Landscapes</td>
</tr>
<tr>
<td>Jumeria – Commercial Development</td>
<td>2004</td>
<td><strong>PUDLO CWP</strong> Underground Car Park and Basement <strong>Membrane Free</strong></td>
<td>Hill International and Holford Associates, Al Shafar Transport &amp; Contracting Co. LLC</td>
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<tr>
<td>AIG</td>
<td>2004</td>
<td><strong>PUDLO CWP</strong> Two Storey Basement BS 810 Grade 4 <strong>Membrane Free</strong></td>
<td>Mott MacDonald, Duffy Construction, Mowlem &amp; Co</td>
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<td>Wimbledon All England Lawn Tennis Club, Centre Court, Wimbledon, UK</td>
<td>2005</td>
<td><strong>PUDLO CWP, INSTALASTIC</strong> Phase II – Terraces being replaced using <strong>PUDLO CWP</strong> modified lightweight (Lytag) concrete, plus <strong>INSTALASTIC</strong> waterproof coating</td>
<td>Galliford Try Construction, BDP Consultants</td>
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<tr>
<td>National Sports Stadium Wembley, London, UK</td>
<td>2005</td>
<td><strong>INSTAPRUF Floor Topping</strong> Surface finish to all terraces, staircases and landings</td>
<td>Multiplex, PC Harrington</td>
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<tr>
<td>Octavia Housing Trust Kensal Road, London, UK</td>
<td>2005</td>
<td><strong>PUDLO CWP</strong> Mixed use residential and commercial <strong>PUDLO used for basement area Membrane Free</strong></td>
<td>Campbell Reith Hill, Mode Best Builders</td>
</tr>
<tr>
<td>Project Description</td>
<td>Year</td>
<td>品牌</td>
<td>Details</td>
</tr>
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<tr>
<td>Big Yellow Storage Box, London, UK</td>
<td>2005</td>
<td>PUDLO CWP</td>
<td>Large storage basement Membrane Free</td>
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<tr>
<td>Grosvenor Waterside London, UK</td>
<td>2005</td>
<td>PUDLO CWP</td>
<td>Basement of luxury apartments next to the River Thames Membrane Free</td>
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<tr>
<td>Harrow Road, London, UK</td>
<td>2005</td>
<td>PUDLO CWP</td>
<td>Mixed use residential basements Membrane Free</td>
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<tr>
<td>Caxton Hall, London, UK</td>
<td>2005</td>
<td>PUDLO CWP</td>
<td>Commercial underground basement Membrane Free</td>
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<tr>
<td>Heathrow Airport Terminal 5, UK</td>
<td>2005</td>
<td>PUDLO SCC</td>
<td>250 large machinery plinths to provide level, high-strength bases</td>
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<td>Victoria Square, Belfast, UK</td>
<td>2005</td>
<td>PUDLO CWP, hDR Waterstop</td>
<td>City centre retail development - underground car parking Membrane Free</td>
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<td>Londonderry Hospital, Belfast, UK</td>
<td>2005</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Underground facility building Membrane Free</td>
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<td>Sheffield Museum, Sheffield, UK</td>
<td>2005</td>
<td>INSTAPRUF, INSTACEM Primer Latex, INSTALASTIC</td>
<td>Flooring project</td>
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<td>King's College, London UK</td>
<td>2005</td>
<td>PUDLO CWP Super 5, INSTACEM Primer Latex</td>
<td>Underground Restaurant - tanking works wall and floor renders Membrane Free</td>
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<td>Project Location</td>
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<td>Materials Used</td>
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<tr>
<td>Ely Municipal Swimming Pool, Ely, UK</td>
<td>2005</td>
<td>PUDLO CWP, Waterproof Cone Shell, PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Godfrey &amp; Hicks, Alan Newport Ltd</td>
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<tr>
<td>10 Alverston Road, London, UK</td>
<td>2005</td>
<td>Swimming Pool Membrane Free, PUDLO CWP, hDR Waterstop, INSTALASTIC</td>
<td>Venice Properties</td>
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<tr>
<td>2 Stormont Road, Hampstead, London</td>
<td>2005</td>
<td>PUDLO CWP, hDR Waterstop, INSTALASTIC, Large basement Membrane Free</td>
<td>Zenon Builders</td>
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<tr>
<td>10 Alverston Road, London</td>
<td>2005</td>
<td>PUDLO CWP, INSTALASTIC, INSTACEM Primer Latex, Swimming Pool Membrane Free</td>
<td>Venice Properties</td>
</tr>
<tr>
<td>Bancroft School</td>
<td>2005</td>
<td>PUDLO CWP, hDR Waterstop, Sports Hall, manhole covers and lift pits Membrane Free</td>
<td>Alan Conisbee &amp; Associates, Modebest Builders Ltd, Killby &amp; Gayford</td>
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<tr>
<td>Drift Park, Rhyl Promenade</td>
<td>2005</td>
<td>PUDLO CWP, hDR Waterstop, INSTAFLEX PU25, Regeneration of Water Play Pool Membrane Free</td>
<td>Edmund Nuttall Ltd, Burdens Civil Engineering, Brock Carmichael Associates</td>
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<tr>
<td>54 Richmond Hill, Richmond, Surrey</td>
<td>2005</td>
<td>INSTAFLEX PU25, hDR WATERSTOP, INSTACEM PRIMER LATEX, INSTACEM POLYMER FLOOR, INSTASET RAPID MORTAR, Swimming Pool</td>
<td>Michael Barclay Partnership, Elston Developments</td>
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<tr>
<td>117-121 New Zealand Avenue, Walton on Thames, Surrey</td>
<td>2005</td>
<td>PUDLO CWP, INSTACEM Membrane Free</td>
<td>Whitby Bird, PC Harrington Contractors</td>
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<td>Kirkley High School</td>
<td>2005</td>
<td>PUDLO CWP, Kite Media Centre Basement Membrane Free</td>
<td>Michael Barclay Partnership, PJ Spillings Ltd</td>
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<tr>
<td>Project Name</td>
<td>Year</td>
<td>Description</td>
<td>Consultant/Builder</td>
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<td>Amberswift Ltd</td>
<td>2006</td>
<td>PUDLO CWP, Residential RefurbishmentMembrane Free</td>
<td>Ground Construction Ltd Foggo Associates</td>
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<tr>
<td>Hans Place</td>
<td>2006</td>
<td>PUDLO CWP, Deep Basement ConstructionMembrane Free</td>
<td>JAC Construction Ltd</td>
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<td>Regal Homes</td>
<td>2006</td>
<td>PUDLO CWP, Membrane Free</td>
<td>Shaun Dixon Twigg Brown Architects</td>
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<td>Seymour Walk</td>
<td>2006</td>
<td>PUDLO CWP, Membrane Free</td>
<td>Elston Developments Morrish &amp; Partners</td>
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<td>Avenue Road</td>
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<td>PUDLO CWP, Deep Basement ConstructionMembrane Free</td>
<td>Wolff Architects Michael Barclay Partnership Rackham Construction</td>
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<td>Bancroft School</td>
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<td>Alan Conisbee and Associates Killby &amp; Gayford</td>
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<td>Hatton Place</td>
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<td>PUDLO CWP, Membrane Free</td>
<td>Reliance Homes Ltd</td>
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<td>Ennismore Gardens</td>
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<td>PUDLO CWP, Deep Basement ConstructionMembrane Free</td>
<td>Reliance Homes Ltd</td>
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<tr>
<td>Hungerford School</td>
<td>2006</td>
<td>PUDLO CWP, INSTALASTIC, hDR Waterstop,INSTAFLEX Membrane Free</td>
<td>SMC Corstorphine &amp; Wright Neil Cott Construction Ltd P Brady Formwork</td>
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<td>Kilburn Lane</td>
<td>2006</td>
<td>PUDLO CWP, hDR Waterstop, INSTAFLEXDeep Basement Construction Membrane Free</td>
<td>Shaun Dixon Construction Jenkinson Associates Barry Smith Consultants</td>
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<tr>
<td>Location</td>
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<td>Contractor/Builder</td>
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<td>Rope Walk</td>
<td>2006</td>
<td><strong>PUDLO CWP, hDR Waterstop, INSTAFLEX PU25, INSTAFLEX</strong></td>
<td>Packman Lucas</td>
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<td></td>
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<td>Deep Basement Construction and Swimming Pool Membrane Free</td>
<td>Joseph Gallagher Ltd</td>
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<td>University of East London</td>
<td>2006</td>
<td><strong>PUDLO CWP</strong></td>
<td>HBG Construction</td>
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<td></td>
<td>Membrane Free</td>
<td>O'Keefe Construction Ltd</td>
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<td></td>
<td></td>
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<td>FB Architects</td>
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<tr>
<td>Chandlers Cross</td>
<td>2006</td>
<td><strong>PUDLO CWP</strong></td>
<td>Pinedene Builders</td>
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<td></td>
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<td>Membrane Free</td>
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<td>Ellesborough Road</td>
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<td><strong>PUDLO CWP</strong></td>
<td>Thermonex Ltd</td>
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<td>Southwark Bridge</td>
<td>2006</td>
<td><strong>PUDLO CWP</strong></td>
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<td>Membrane Free</td>
<td></td>
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<td>Newmarket Leisure Centre</td>
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<td><strong>PUDLO CWP</strong></td>
<td>MJS Construction Limited</td>
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<td>The Cheltenham House</td>
<td>2006</td>
<td><strong>PUDLO SCC</strong></td>
<td>Blackbrick Building Company</td>
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<td>New Build House Membrane Free</td>
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<td>Stallard Construction</td>
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<td>Martello Beach Holiday Park</td>
<td>2006</td>
<td><strong>PUDLO CWP</strong></td>
<td>Aquascapes</td>
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<td></td>
<td></td>
<td>Membrane Free</td>
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</table>
Enclosure 2

Project specific Case Studies
Unprecedented in scale, design and diversity, the £320 million retail centre is one of Europe's largest urban regeneration projects and a milestone in the revitalisation of Belfast city centre.

Many of the world's major cities sit on estuarial floodplains, for good historic and socio-economic reasons, and Belfast in Northern Ireland is no exception. But a strategically excellent location is no guarantee of its suitability for large scale construction, as examples such as the recent flooding of New Orleans demonstrate.

There may be little risk of hurricanes or storm surges battering Belfast, but its geography has its own unique drawbacks, as the team building the vast Victoria Square development found out, constructing a three storey deep basement for underground car park and retail.

Sleech is the local term for soft estuarine quasi-thixotropic deposits that underlie both banks of the River Lagan in the heart of the city.

Up to the end of the 19th century the entire centre of the city was supported on a forest of timber piles, most of which are still performing their original function. But 19th century engineers never attempted to build deep basements, certainly not on the Victoria Square scale.

The 150m square excavation would be challenge enough, sleech being one of the most unco-operative soils in the UK, but at Victoria Square sleech is just one of the underground nasties.

The benefits of using the membrane free PUDLO CWP system soon became apparent. PUDLO CWP is an integral waterproofing admixture that is specially formulated to protect against water ingress and aggressive chemicals and to withstand hydrostatic pressure. With the amount of sleech around the basement it was imperative to use an admixture that was both corrosion resistant, and capable of withstanding hydrostatic pressure.

PUDLO is BBA approved and CE Mark Certificated. Manufactured under ISO 9001 quality procedures, it is easy to specify and use and can dramatically save construction time and materials without compromising on watertightness.

The project demonstrates how structures can be designed to BS 8110 rather than BS 8007 thus saving on structural steelwork, in addition to the membrane material costs and construction time savings, and are watertight, even in site conditions as challenging as Victoria Square.

**Client**
Multi Development U.K. Ltd

**Main Contractor**
Farrans

**Specialist Concrete Admixture & Sealants**
David Ball Group plc
PUDLO WATERPROOFING KNOCKS ONE MONTH OFF CONSTRUCTION SCHEDULE FOR AIG HEADQUARTERS

A tight schedule and total waterproofing were the challenges facing the developers of American Insurance Group new European headquarters. By providing an easy-to-use, membrane-free waterproofing system, the David Ball Group helped achieve all project goals, whilst significantly reducing contract costs and saving contractors over one month in construction time.

AIG is the world’s leading international insurance and financial services organisation. AIG’s European headquarters were purpose designed and built for them in the heart of London’s financial centre.

AIG’s headquarters consist of a 14 storey office block and a two storey basement. The first underground level provides space for mechanical and electrical facilities and the second level provides space for document storage and car parking. The underground structure had to be completely watertight because the basement was to be used for document storage. A totally dry environment fulfilling Grade 4 level of BS 8102 was required.

The original designs involved a membrane system but the subcontractors on the project, Duffy Construction, recommended an alternative waterproofing system. They recognised the benefits of using the membrane free PUDLO CWP system. PUDLO CWP is an integral waterproofing admixture that is specially formulated to protect against water ingress and aggressive chemicals and to withstand hydrostatic pressure. Having used PUDLO previously on other projects, the subcontractors knew that the system is BBA approved, easy to use and can dramatically save construction time without compromising on watertightness. In fact one entire month was taken out of the construction programme by using the membrane free system.

Waterproof concrete was used to create the 1.2 metre thick base slab positioned 7 metres below ground level and this slab was placed on piled foundations. hDR waterstop was used on all construction joints to provide complete water resistance and excellent resistance to the passage of methane, carbon dioxide and radon. Had a membrane system been used there would have been the potential for leaks around each pile head, the PUDLO system eradicated this risk. The PUDLO system also eliminated the problems that can arise with membrane systems around wall and slab joints and other overlapping areas.

Steven Brunswick, Technical Services Director at Mowlem recognised the advantages of using a concrete waterproofing admixture. The admixture reduces the water content and, as the concrete cures, the admixture seals the potential water paths. He explained, “the concrete is in itself the waterproofing membrane” and therefore the PUDLO system was the preferred choice for the AIG development.

CONTRACTOR
Mowlem & Co

CONSULTING ENGINEERS
Mott MacDonald

ARCHITECT
Kohn Pederson Fox Associates

READY MIX COMPANY
London Concrete

SPECIALIST CONCRETE ADMIXTURES AND SEALANTS
David Ball Group plc
PUDLO waterproof concrete was used to construct a series of wave flumes and storage tanks in Howbery Park, Oxon. HR Wallingford, a World leading independent company specializing in large scale laboratory research in civil engineering hydraulics and the water environment, commissioned and designed the tanks to form part of a new research and consultancy facility. They specified the use of PUDLO waterproofing admixture in the concrete to ensure that the tanks will be completely waterproof and have a good surface finish.

HR Wallingford specialises in providing consultancy services covering the interaction between surface water resources and rural and urban development. This work is underpinned by research programmes carried out at Wallingford, in Europe and throughout the world.

Toureen Contractors constructed the 2 wave flumes each 2.0m high x 1.8m wide x 40m long and the 1.2m deep x 2.4m wide x 60m long storage tank.

Each tank undergoes rigorous testing to check that there is zero leakage. Any loss of water (other than pre-calculated evaporation) would make future research results inaccurate and therefore it is critical that the tanks are, and will remain, watertight throughout their service life.

Client
HR Wallingford

Main Contractor
Toureen Contractors

Specialist Concrete Admixture & Sealants
David Ball Group plc
Enclosure 3

Certificate of Registration

This is to certify that the Quality Management System of

David Ball Group Plc
Huntingdon Road, Bar Hill,
Cambridgeshire CB3 8HN

applicable to

Selection, grading and supply of specialist industrial sands and manufacture of specialist cement products, admixtures and floor treatment materials

has been assessed and registered by
National Quality Assurance Limited against the provisions of

BS EN ISO 9001 : 2000

This registration is subject to the company maintaining a quality management system, to the above standard, which will be monitored by NQA.

The Seal of National Quality Assurance Limited was hereto affixed in the presence of:

Managing Director

Certificate No: 2899
Date: 2 December 1993
Reissued: 18 November 2003
Valid Until: 18 February 2007
EAC Code: 16/29
CERTIFICATE OF FACTORY PRODUCTION CONTROL

In compliance with the Directive 89/106/EEC of the Council of European Communities of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to the construction products (Construction Products Directive — CPD), amended by the Directive 93/68/EEC of the Council of European Communities of 22 July 1993, it has been stated that the construction product:

PUDLO CWP
produced by the manufacturer:
David Ball Group PLC
Huntingdon Road
Bar Hill
Cambridge CB3 8HN

in the factory:
Bar Hill

is submitted by the manufacturer to the initial type-testing of the product, a factory production control and to the further testing of samples taken at the factories in accordance with a prescribed test plan and; that the notified body, the British Board of Agrément, has performed the initial inspection of the factories and of the factory production control and performs the continuous surveillance, assessment and approval of the factory production control.

This Certificate attests that all provisions concerning the attestation of factory production control described in:

BS EN 934-2 : 2001

were applied.

This Certificate was first issued on 22nd January 2007 and remains valid for as long as the conditions laid down in the harmonised technical specification in reference or the manufacturing conditions in the factory or the FPC itself are not modified significantly.

Signed on behalf of the British Board of Agrément:
Date: 22nd January 2007
Expiry date: 31st January 2010
Notified body reference number: 0836

British Board of Agrément, Bucknalls Lane, Garston, Watford, Hertfordshire WD25 9BA
Telephone: 01923 665300  e-mail: mail@bba.star.co.uk
Fax: 01923 665301  website: www.bbacerts.co.uk

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Enclosure 4

PUDLO CWP Technical Data Sheet, Health & Safety Data Sheet & PUDLO User Guide
PUDLO CEMENT
WATERPROOFING POWDER

DESCRIPTION
A multi-component, single pack, waterproofing, plasticising, permeability reducing, corrosion inhibiting admixture. Outperforms any other admixture of its kind.

QUALITY ASSURANCE
PUDLO Cement Waterproofing Powder is a Quality Assured product produced to British Standards BS EN ISO 9001: 2000. PUDLO Cement Waterproofing Powder is BBA accredited holding Certificate No 01 / 3843.

USES
- Integral waterproofing of all concrete and cementitious based systems
- To reduce permeability, absorption and efflorescence
- To reduce water/cement ratio (up to 15%)
- To provide long-term concrete durability
- Applicable in all structural, ready-mix and precast concretes
- Internal curing mechanism
- To reduce shrinkage
- To inhibit corrosion (Factor of 5 reduction in chloride ingress)

BENEFITS
- Provides permanent reduction in permeability
- Reduction in carbonation of concrete
- Improves resistance to sulphate, chloride and chemical attack
- Enhances protection against frost attack
- Provides sound concrete for protection of reinforcement steel
- Increases ultimate compressive and tensile strengths without increase in cement content
- Reduces bleed and segregation
- Reduces efflorescence and staining
- Ready to use, readily dispersed powder, supplied in convenient pre-weighed bags
- Proven world-wide track record with over 100 year history

TECHNICAL DATA
Typical Performance - 350Kg/m³ PC with Thames Valley natural flint based aggregates

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<thead>
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<th>Control (no admixture)</th>
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<tr>
<td>Water Sorptivity mm/min</td>
<td>0.65</td>
<td>0.05</td>
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<tr>
<td>Water permeability m²/s x10⁻¹³</td>
<td>39.45</td>
<td>12.1</td>
</tr>
<tr>
<td>Oxygen Diffusion m²/s x10⁻⁸</td>
<td>0.83</td>
<td>0.71</td>
</tr>
<tr>
<td>Chloride Diffusion m²/s x10⁻¹³</td>
<td>2.05</td>
<td>0.42</td>
</tr>
<tr>
<td>7 day strength Mpa</td>
<td>33</td>
<td>52</td>
</tr>
<tr>
<td>28 day strength Mpa</td>
<td>43</td>
<td>61</td>
</tr>
</tbody>
</table>

Independent Test Data: Concrete Durability Group, Department of Civil Engineering, Imperial College of Science, Technology and Medicine, LONDON, SW7 2BU
DOSAGE AND MIXING INSTRUCTIONS
The optimum dosage of PUDLO Cement Waterproofing Powder to meet specific requirements should always be determined by trials using materials and conditions that will be experienced in use.

As a guide normal dosages of PUDLO Cement Waterproofing Powder should be in the range 2 – 3% by weight of cement. For example 1kg PUDLO CWP bag/50kg of cement. To obtain maximum benefit it is recommended that the water cement ratio should not exceed 0.40.

With the correct dosage of PUDLO Cement Waterproofing Powder determined the required amount should be added to the mix, preferably with or immediately after cement addition.

The concrete or mortar produced must be thoroughly mixed until homogeneous.

It is essential that good concreting practice is performed and maintained at every stage of the application process.

PACKAGING AND SHELF LIFE
PUDLO Cement Waterproofing Powder is packaged in 1kg, 2kg, 8kg or 25kg bags. The powder has a shelf life of 24 months minimum if stored in good conditions.

HEALTH AND SAFETY
PUDLO Cement Waterproofing Powder is non-toxic and safe to use. However, protective clothing and a dust mask should be worn while mixing and applying the material. Health and Safety data sheet is available on request.
IDENTIFICATION OF THE SUBSTANCE:
Admixtures for cement and concrete – PUDLO Concrete Waterproofing Powder

MANUFACTURING COMPANY:
David Ball Group plc, Huntingdon Road, Bar Hill, Cambridge, CB3 8HN.
Telephone 01954 780687.

HAZARDS IDENTIFICATION:
On contact with environmental moisture or body fluids (e.g. sweat), cementitious powder forms an alkaline solution that over a period of time can cause irritation to the skin and eyes. In cases of prolonged exposure, alkali burns can develop.

RISK PHRASES:
R33 - danger of cumulative effects
R36 and R38 - irritant to eyes and skin

FIRE FIGHTING MEASURES
Does not present any particular fire hazard – treat as ordinary Portland cement

HANDLING AND STORAGE:
No special requirements necessary, but keep dry – treat as ordinary Portland cement

SPILLAGE PROCEDURES:
Treat as a common mess, vacuum powder and dispose of sensibly. Do not sweep. Wear a dust mask. The use of water is not recommended.

COMPOSITION AND USES:
A blend of cement powders and waterproofing agents. Used as a waterproof admixture for concrete.

FIRST AID MEASURES:
Safety phrases: S5, S6, S7
Inhalation (S6): remove to fresh air. If symptoms persist seek medical attention.
Skin contact (5): wash effected areas thoroughly with soap and water. If irritation, pain or other skin problems arise seek medical advice.
Eye contact (S5): irrigate thoroughly with clean, fresh water. In severe cases seek medical attention without delay.
Ingestion (S7): Do not induce vomiting, but wash out mouth with fresh, clean water and give the patient plenty of water to drink.
EXPOSURE LIMITS and PERSONAL PROTECTION:

Occupational limits: Total inhalable dust, 10mg/m³ 8-hour time weighted average.
Exposure standards: Respirable dust, 5mg/m³ 8-hour time weighted average
Personal protection: Protective clothing including goggles and dust masks should be worn at all times.

PHYSICAL AND CHEMICAL PROPERTIES:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state</td>
<td>Particulate</td>
</tr>
<tr>
<td>Particle size distribution</td>
<td>0.1 to 60 micron</td>
</tr>
<tr>
<td>Appearance</td>
<td>grey/white powder</td>
</tr>
<tr>
<td>Odour</td>
<td>none</td>
</tr>
<tr>
<td>Alkalinity of wet powder</td>
<td>PH14</td>
</tr>
<tr>
<td>Flash point</td>
<td>None</td>
</tr>
<tr>
<td>Ignition temperature</td>
<td>None</td>
</tr>
<tr>
<td>Explosive limits</td>
<td>None</td>
</tr>
<tr>
<td>Thermal decomposition</td>
<td>None, provided proper use of Material</td>
</tr>
<tr>
<td>Hazardous decomposition Products</td>
<td>None</td>
</tr>
<tr>
<td>Hazardous reactions</td>
<td>None</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

The procedures in the User Guide are part of the manufacturer’s quality assured scheme. The procedures ensure that good practice and adequate recording take place. The manufacturer’s warranty will be issued on projects where the User Guide has been followed or where deviations have been applied for in writing and approved by the PUDLO Manager. Unauthorised use of non-approved alternative materials, products, and practices will render the warranty null and void.

A pre-contract induction meeting will be held with the PUDLO Manager and the Contractor’s Site Foreman. The Site Foreman will sign the PUDLO Training Record at the end of the meeting to confirm that they understand the procedures in the User Guide.

Further training meetings may be necessary, if significant changes of personnel take place during the project.

A set of drawings and a schedule of work will then be given to the PUDLO Manager.
2 PUDLO CONCRETE GUIDELINES

PUDLO modified concrete. The handling and placing of PUDLO modified, waterproofed concrete is no different from ordinary concrete and current good practice should be followed. PUDLO is a white dry powder with unlimited shelf life provided materials are stored in dry conditions. The material is supplied, pre-weighed, soluble bags complete with batch numbers.

Concrete Supplier. PUDLO is available from ready mix companies. Concrete must only be purchased from companies holding third party ISO 9001: Product Conformity Certification for Ready Mixed Concrete, such as QSRMC, BSI or similar approved.

Mix Design approval. Contractor is to ensure that the ready mix supplier discusses the mix design with PUDLO manager and will wait for PUDLO manager to approve mix design prior to pouring. Mix must meet requirements of this specification and be in accordance with current British Standards.

Trial Mixes. Where the Engineer requests trial mixes be carried out, the PUDLO manager should be involved.

Constituent Parts. PUDLO manufacturer is positive about blended cements (GGBS, pfa and micro silica) and will approve such mix designs.

Compressive Strength. At least 35 N/mm² at 28 days, or greater if required by the Engineer.

Admixture Dosage. Concrete shall contain PUDLO at the minimum rate of 2% by weight of cement. (one 8kg bag per cubic metre added prior to loading). Concrete suppliers are to submit the mix design to David Ball Group for approval prior to supply.

Water Cement Ratio. Not to exceed 0.4. No truck driver or pump operator is allowed to add water once it has left the batching plant without the written approval of the PUDLO manager.

Slump. Unless otherwise agreed, concrete shall not be placed with a slump less than 75mm or greater than 160mm. The contractor should specify an S3 consistency with a target slump of 120mm. Regular slump tests will be carried out by the contractor and results recorded. The placed concrete shall be placed at a workability/consistence as declared on the suppliers mix design certificate and delivery ticket (which should be the same) and within the tolerances specified in BS 8500. A slump test shall be carried out on the first delivery of every pour. A record of all slump tests shall be maintained on site. Any concrete found to be outside the tolerances of BS8500 shall only be placed in the permanent works on the understanding that it is not covered by the insurance backed warranty.

Minimum Cement Content. 350kg cement content per m³

Plasticisers. Addition of PUDLO reduces the water demand by approximately 10-12%. A water reducing agent or plasticiser may be added at the necessary dosage to provide the required slump and low water cement ratio.

Recording. For each pour the volume, slump and ticket number to be recorded

Mixing. Addition of PUDLO prior to loading improves mixing process. Concrete is to be thoroughly mixed (adequate mixing complete within 15 minutes). When ready-mix trucks arrive on site the truck will spin the drum up to max speed for a minimum of 2 minutes prior to discharge of concrete.

Pumping. The pump operatives shall ensure that no grout-rich priming material will be allowed to discharge into the structure. Such material shall be disposed of, off site.
Self-Certification. Approval for self-certification is granted at the discretion of the PUDLO Manager, and is on the understanding that in the event of any defects occurring within the self-certificated works requiring remedial action, the cost of these works will be chargeable to the self-certificating contractor.

3. JOINT DETAILS

**hDR Waterstop** to be used to seal all construction joints. Dimensions of **hDR Waterstop** are 20mm x 10mm. A rebate sized 10mm deep and 10mm wide is to be preformed in the concrete so that the waterstop can be inserted and then secured continuously using **INSTAFLEX PU25 Mastic** and masonry nails if required.

![Kicker joint](image)

The concrete stop-end, slab-joint and kicker wall (excluding rebate area) to be retarded and washed while still green, to expose the aggregate face and provide a keyed surface. Retarder gel to be used for vertical surfaces. Kicker walls to be compacted and finished to same standard as floor slab.

Prior to inserting the waterstop, the rebate and concrete face is brushed or blown clean of all loose material.

Once **hDR Waterstop** is secured the new concrete can then be placed and properly compacted taking care not to dislodge waterstop.

When unrolling the waterstop roll it the opposite way to the roll. This will help the waterstop straighten when placing in rebate.

Nail the end of the waterstop in place then reel out the required length, nailing every so often to hold down. The waterstop must be protected once fitted with plastic sheets to prevent the waterstop from snaking.

The weather can affect the workability of the waterstop- if its hot then the waterstop with un roll easily, if its cold then the waterstop will be stiffer.
For continuity of the hDR Waterstop from one pour to the next, the previous pours waterstop must be located and overlapped with the new waterstop being laid for the next pour, so allow a 100mm overlap at ends.

hDR Waterstop is to be protected from water to prevent it from expanding. If it expands prior to concrete being placed it must be taken out and replaced.

For movement joints, please consult PUDLO manager.

Service Penetrations

Service pipes may be simply ‘cast in place’. PUDLO concrete is cast around the services and thoroughly compacted. Care must be taken not to drop or pour concrete directly onto pipe surfaces as this may dislodge the hDR Waterstop.
Bolt Holes

Tie bolts through formwork shall be placed through a plastic sleeve or other approved method. The plastic sleeve may consist of a plastic tube cut to the correct length and with a separate cone attached to each end. Remove flange from each end of plastic sleeve and clean hole of any dirt or debris.

From the external or internal wall face a rubber plug of the appropriate size should be inserted into the end of the plastic sleeve and the hole rendered up and made good using INSTACEM Concrete Repair.

If access to the external face is not possible, then a rubber plug should be rammed into the centre of the bolthole. A small piece of hDR Waterstop joint-strip should then be rolled into a ball and pushed into the centre of the bolthole up against the rubber plug. A second rubber plug should then be rammed in up against the hDR Waterstop joint-strip and then the hole made good as before using INSTACEM.

4. PLACING PROCEDURES

Formwork should be erected as for pump or highly workable concrete. Boltholes are permitted and should be filled in accordance with the details given.

PUDLO concrete is to be carefully placed and fully compacted on site by competent staff. PUDLO concrete must not be allowed to fall more than 2.0m from the end of the static line pump or skip hopper. The placing, compaction and curing of the concrete is to be in accordance with current standards of good concrete practice.

The size of wall or slab pours are determined by the guidance given in BS 8110 and will be effected by the presence of restraints. If in doubt, consult the project engineer.

5. CURING AND LOADING

Normal concrete practice should be followed using an agent with not less than 80% efficiency. Concrete must be properly cured to retain mix water. This can be achieved by leaving formwork in place for 48 hours or in the case of slabs, by applying an appropriate curing membrane.
Loading of the hardened concrete must not take place until the concrete has reached its appropriate strength and in any case, should not take place for at least 7 days or as instructed by the project engineer. Care must be taken not to overload suspended slabs.

6. RECORDING

Each PUDLO pour shall be recorded on the PUDLO Site Record Form.

The form is to be filled in by the PUDLO manager until he/she gives approval for the contractor to move to self-certification.

Essential checks include: - correct vibration equipment, w/c ratio of concrete, reinforcement cover, cleanliness of kicker walls and construction joints, compaction of concrete during placement and curing regime.

The Contractor shall remove debris, re-fix hDR Waterstop, alter reinforcement position or carry out any reasonable preparation works as required by PUDLO manager to avoid non-conformance. Refusal to make the necessary alterations will impact the manufacturer’s warranty and guarantee position and written notice of this will be given.

PUDLO manager will continue to make spot check and post pour inspections and non-conformances to be rectified as soon as possible.

As well as site record forms, a record drawing to be coloured in for every PUDLO concrete pour.

Copies of all site record forms and drawings must be forwarded to David Ball Group plc prior to issue of any warranty documents. Where NHBC warranty is required project details must be forwarded to NHBC Engineering Services via David Ball Group plc at least 2 weeks prior to pours.

7. POST POUR INSPECTION

PUDLO manager will inspect previously cast sections.

The contractor will be advised in writing should remedial works be required, and how these are to be carried out. These works are to be completed prior to “handing over” any such sections.

All making-good to be carried out as instructed by PUDLO manager with labour and materials at the contractor’s cost. No other materials shall be used unless approved in writing by PUDLO manager.

8. WARRANTY

The manufacturer will issue a 30-year company warranty for the waterproof concrete and construction joints providing that the methods set out in this User Guide are followed.
## 9. PRODUCT RANGE

Below is a checklist of our waterproofing products. Amounts required will depend on the application, surface condition and thickness. See datasheets for more information and consult PUDLO manager.

<table>
<thead>
<tr>
<th>Product</th>
<th>Pack Size</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUDLO CWP</td>
<td>8kg</td>
<td>Admixture providing integral concrete waterproofing for basements, swimming pools, tanks, tunnels, bridges</td>
</tr>
<tr>
<td>hDR Waterstop (hydrophilic joint strip)</td>
<td>5 linear metres rolls 10mm x 20mm</td>
<td>Waterstop to be used with PUDLO modified concrete for all construction joints. Retarding agent to be used and washed off at all concrete joint faces prior to placing hDR Waterstop.</td>
</tr>
<tr>
<td>INSTAFLEX PU25 Mastic (flexible joint sealant)</td>
<td>600ml tube Barrel gun&amp;nozzles</td>
<td>Mastic to be used to fix waterstop in place if masonry nails are not suitable and to seal all expansion/movement joints</td>
</tr>
<tr>
<td>INSTACEM Concrete Repair System</td>
<td>25kg plastic tub</td>
<td>INSTACEM to be used to make good bolt holes, tie holes in PUDLO modified concrete – if large areas need repair please consult DBG</td>
</tr>
<tr>
<td>INSTACEM Primer Latex (sealer for INSTAPRUF)</td>
<td>5 litres</td>
<td>Primer to be used prior to making good with INSTACEM CRS</td>
</tr>
<tr>
<td>INSTALASTIC</td>
<td>35kg unit (comprising of 25kg powder &amp; 10 litres of liquid) grey</td>
<td>A waterproof membrane/coating to be used where concrete thicknesses cannot be obtained or over joints or where additional vapour barrier is required</td>
</tr>
<tr>
<td>INSTACEM P Protective Coating</td>
<td>30kg unit (20kg powder &amp; 10 litres liquid)</td>
<td>Protective coating to enhance finish, carbonation reduction, increase chemical resistance etc</td>
</tr>
<tr>
<td>INSTASET Rapid Mortar</td>
<td>25kg bag</td>
<td>Very rapid setting water-plug cement to stop active waterflow and allow repair to be completed</td>
</tr>
<tr>
<td>INSTAPRUF</td>
<td>29kg unit (25kg powder &amp; 4 litres liquid)</td>
<td>Thin, self-smoothing waterproof floor covering to enhance finish, increase abrasion-resistance and allow steam cleaning to concrete floor</td>
</tr>
</tbody>
</table>
Enclosure 5

BBA Certificate
THIS CERTIFICATE RELATES TO PUDLO CWP (CEMENT WATERPROOFING POWDER), A HYDROPHOBIC, PORE-BLOCKING ADMIXTURE TO PROVIDE WATERTIGHT CONCRETE OR RENDER.

1. The Building Regulations 2000 (as amended) (England and Wales)

   In the opinion of the British Board of Agrément the use of Pudlo CWP (Cement Waterproofing Powder) is not subject to these Regulations.

2. The Building (Scotland) Regulations 2004

   In the opinion of the British Board of Agrément the use of Pudlo CWP (Cement Waterproofing Powder) is not subject to these Regulations.

3. The Building Regulations (Northern Ireland) 2000

   In the opinion of the British Board of Agrément the use of Pudlo CWP (Cement Waterproofing Powder) is not subject to these Regulations.

4. Construction (Design and Management) Regulations 1994 (as amended)

   Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

   Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.

   See sections: 6 Delivery and site handling (6.1 and 6.3), 13 Placing (13.5), and 17 Rendering (17.2).
Technical Specification

5 Description

5.1 Pudlo CWP (Cement Waterproofing Powder) is a chloride-free cementitious powder admixture for Portland cement concrete and sand/cement render enabling a significant reduction in the water/cement ratio of the mix while enhancing the workability. When incorporated in concrete it enhances the water resistance and durability of the hardened concrete.

5.2 The product is used with a suitable water reducing or superplasticising admixture that complies with BS EN 934-2 : 2001. The water reducing or superplasticising admixture is used to further lower the water/cement ratio or improve the fluidity of the mix.

5.3 The product is manufactured by a blending process. Quality control checks are carried out on the raw materials, during the production processes and on the final product.

6 Delivery and site handling

6.1 The product is packaged in 1 kg, 2 kg, 2.5 kg, 8 kg or 25 kg bags.

6.2 The product is not flammable. It should be stored in dry conditions and has a minimum shelf-life of one year.

6.3 The product should be handled on site using the normal health and safety procedures associated with cementitious materials.

Design Data

7 General

7.1 Concrete containing Pudlo CWP can be designed in accordance with BS EN 206-1 : 2000 for use as all normal types, including precast, pre-stressed, post-tensioned, ready-mixed, reinforced, slip formed, sprayed and pumped concrete.

7.2 The product produces concrete with enhanced durability and improved protection against reinforcement corrosion by:

- minimising the water/cement ratio of the concrete mix resulting in the reduction of the capillary network of the cured concrete, and
- providing hydrophobic action that protects resulting concrete against water ingress via absorption or hydrostatic pressure.

7.3 Compared to similar plain concrete, use of the system promotes:

- reduced porosity
- reduced permeability
- increased water resistance
- increased corrosion resistance.

7.4 These properties enable the concrete structure, when built using waterstops as described in section 15, to remain watertight without the requirement for additional applied protection.

7.5 The concrete can be used in structures such as basements, roofs, swimming pools, tunnels, and culverts, without the requirement for additional applied protection. Where exposure to aggressive soil conditions or chemicals is anticipated, a full assessment of the site should be made. In these situations the Certificate holder should be consulted on the suitability of the product.

7.6 A render made using the product will also be water resistant and less permeable.

7.7 The product is compatible with Portland cements, pulverized-fuel ash, ground granulated blastfurnace slag, silica fume blends and other regular concreting materials.

7.8 Use of the product with an air-entraining agent is not covered by this Certificate.

7.9 The product is not intended for use with gypsum-based plasters.

8 Construction

8.1 Concrete structures built incorporating the product should be designed to the relevant sections of BS 8007 : 1987, BS 8102 : 1990, and BS 8110-1 : 1997.

8.2 Concrete containing the product is suitable for Type B construction as described in BS 8102 : 1990, and it will be suitable for all grades defined in Table 1 of this Standard. For Grades 3 and 4 (where control of water vapour is required), it will be necessary to provide a mix with a sufficiently low vapour permeability in combination with an adequate section thickness (see sections 10.14 to 10.16).

8.3 Basements should be designed in accordance with the guidance given in the Approved Document, Basements for dwellings.[1]


8.4 Walls to be rendered should be prepared in accordance with BS 8000-10 : 1995 and BS 5262 : 1991 and BS EN 13914-1 : 2005 or BS 5492 : 1990 and BS EN 13914-2 : 2005.

9 Mix design

9.1 Concrete containing the product is normally supplied as ready-mixed concrete but may be prepared on sites where there is adequate mix control. Concrete prepared on site should be carried out in accordance with BS 8000-2.1 : 1990, the Certificate holder’s instructions and this Certificate.

9.2 The product should be added to the concrete mix at the rate of 2% by weight of cement.

9.3 The concrete must have a minimum cement content of 350 kgm⁻³ and be batched with a
maximum water/cement ratio of 0.4. Further details of suitable mixes can be obtained from the Certificate holder.

9.4 The workability of concrete can be adjusted using a suitable\(^1\) water reducing or superplasticising admixture that complies with BS EN 934-2 : 2001 to ensure the maximum water/cement ratio given in section 9.3 is not exceeded.

\(^1\) The suitability and compatibility of a water reducing or superplasticising admixture should be evaluated before use and site trials should be carried out to establish the appropriate dose required.

9.5 For sand/cement render mixes the product should be used at the rate of 3% by weight of cement.

10 Concrete properties

10.1 The effect of the product on the properties of concrete designed to the mix specification given in Table 1 are given in Table 2.

<table>
<thead>
<tr>
<th>Table 1 Test mix details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component/Property</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Portland cement (BS 12, Class 42.5 N)</td>
</tr>
<tr>
<td>slump (mm)</td>
</tr>
<tr>
<td>water/cement ratio</td>
</tr>
<tr>
<td>sand</td>
</tr>
<tr>
<td>gravel (Thames Valley)</td>
</tr>
<tr>
<td>Pudlo CWP (kg)</td>
</tr>
<tr>
<td>admix 500 (kg)</td>
</tr>
</tbody>
</table>

\(^{11}\) ±10 kgm\(^{-3}\)

Table 2 Effects of the Pudlo CWP on concrete (specification as Table 2)

<table>
<thead>
<tr>
<th>Property</th>
<th>Test reference</th>
<th>Control concrete</th>
<th>Pudlo CWP/Admix 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>water absorption (%)</td>
<td>BS 1881-122</td>
<td>2.42</td>
<td>1.25</td>
</tr>
<tr>
<td>28 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water vapour [gm/(NS)(^{-1})] permeability</td>
<td>BS 3177</td>
<td>790 x 10(^{-12})</td>
<td>490 x 10(^{-12})</td>
</tr>
<tr>
<td>water permeability [ms(^{-1})]</td>
<td>Taywood/Valenta</td>
<td>3.2 x 10(^{-15})</td>
<td>0.64 x 10(^{-15})</td>
</tr>
<tr>
<td>drying shrinkage (%)</td>
<td>BS 6073-1</td>
<td>0.035</td>
<td>0.032</td>
</tr>
<tr>
<td>wetting expansion (%)</td>
<td>BS 1881-5</td>
<td>0.017</td>
<td>0.009</td>
</tr>
<tr>
<td>compressive strength (\text{N/mm}^2)</td>
<td>BS 1881-116</td>
<td>63</td>
<td>82</td>
</tr>
<tr>
<td>28 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capillary absorption (\text{g/mm}^2 \times 10^{-3})</td>
<td>BS EN 480-5(^{\text{11}})</td>
<td>2.6</td>
<td>0.62</td>
</tr>
<tr>
<td>7 day cure 1 day absorption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 day absorption</td>
<td>4.0</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>90 day cure 1 day absorption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 day absorption</td>
<td>3.9</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>28 day absorption</td>
<td>8.4</td>
<td>2.6</td>
<td></td>
</tr>
</tbody>
</table>

\(^{11}\) To the regime given in this standard and using the mix given in Table 2 of this Certificate.

10.2 The effect of the product on these properties, for a specific mix and site conditions may be evaluated prior to use.

Setting and hardening characteristics

10.3 The setting and hardening characteristics of concrete containing the product or render are similar to the equivalent plain material.

Drying shrinkage and wetting expansion

10.4 The drying shrinkage of concrete containing the product shows a small reduction compared to that of an equivalent plain concrete (see Table 2). The wetting expansion is about half that of the equivalent plain concrete, enhancing the dimensional stability of the concrete with respect to moisture changes.

Mechanical properties

10.5 The compressive strength of concrete containing the product will be higher than the equivalent plain concrete with the same slump.

10.6 The flexural strength of concrete containing the product is similar to that of the equivalent plain concrete of the same 28-day compressive strength.

10.7 The static modulus of elasticity of concrete containing the product is similar to the equivalent plain concrete of the same 28-day compressive strength.

10.8 The use of the product in sand/cement renders will not alter their strength, stability or impact resistance.

Resistance to leaching

10.9 Use of the product will reduce the leaching of lime from the hydrated cement in the concrete.

Potable water

10.10 The Certificate holder should be consulted if it is proposed to use the system in contact with potable water.

Water absorption

10.11 Concrete containing the product shows significantly reduced water absorption characteristics over plain concrete (see Table 2). Initial Surface Absorption (ISAT) values were too low to measure.

Water penetration

10.12 Concrete using the product has significantly greater resistance to water penetration than equivalent plain concretes (see Table 2).

10.13 Use of the product will increase the weather resistance of a render by improving its impermeability.

Water vapour permeability

10.14 Concrete containing the product has a significantly lower permeability to water vapour than the equivalent plain concrete.
Concrete made with a high water/cement ratio can have a water vapour permeability above 3000 \times 10^{-12} \text{ gm(Ns)}^{-1}. The permeability of concrete is strongly dependent on the exact mix design and the figures given in Table 2 indicate the levels that can be obtained.

The appropriate thickness for concrete with a specific permeability to achieve a water vapour resistance of 200 MNs^{-1} or 550 MNs^{-1} (suitable for grades 3 and 4 respectively of BS 8102 : 1990) is given by:

For 200 MNs^{-1}
\[
t = 0.2 \times 10^{12} \times p
\]

For 550 MNs^{-1}
\[
t = 0.55 \times 10^{12} \times p
\]

where \( t \) = concrete thickness (mm) and \( p \) = water vapour permeability in \text{gm(Ns)}^{-1} (from BS 3177 : 1959 test).

The water vapour permeability\(^{(1)}\) of a 2.5 : 1 sand/cement render was reduced from 1300 \times 10^{-12} \text{ gm(Ns)}^{-1} to 860 \times 10^{-12} \text{ gm(Ns)}^{-1} when the product was used in the mix.

\(^{(1)}\) To BS 3177 : 1959.

Reinforcement protection

The high alkalinity (pH>13) of concrete necessary to prevent corrosion of the reinforcement is maintained in Pudlo CWP concrete.

Corrosion of reinforcement is normally caused by the ingress of chloride to the steel or by the reduction in alkalinity of the concrete by the diffusion of carbon dioxide. These processes lead to the breakdown of the steel’s corrosion-protective passive layer. Reduced permeability of concrete containing the product slows down diffusion of aggressive agents into the concrete and confers improved protection against corrosion.

Carbonation resistance

Concrete containing the product has a significantly greater resistance to carbon dioxide diffusion than an equivalent plain concrete due to its reduced permeability.

Frost resistance

The admixtures used in the product entrain a small amount of air, this will help to improve the frost resistance of the concrete.

Sulphate resistance

The lower permeability of concrete containing the product will reduce the ingress of sulphates, however, if sulphate-resistant concrete is required, the Certificate holder should be contacted.

Alkali silica reaction (ASR)

Concrete containing the product should be designed according to BS EN 206-1 : 2000, Section 5.2.3.4.

11 Durability

Pudlo CWP concrete is more durable than equivalent plain concrete due to its reduced permeability.

Installation

12 Site mixing

12.1 The product is added at the correct dose (see sections 9.2 and 9.5) and is pre-mixed with the dry concrete or render constituents.

12.2 The water reducing or superplasticiser should be added after the addition of the product in accordance with the manufacturer’s instructions.

12.3 A water reducing/superplasticising admixture is not used for renders.

12.4 Concrete containing the product can be supplied as ready-mixed concrete or added to the truck mixer on site. Allow one minute mixing time for each cubic metre of concrete.

12.5 Where the product is to be prepared on site, adequate mix control must be available.

13 Placing

13.1 All aspects of placing must be carried out in accordance with BS 8000-2.2 : 1990, the Certificate holder’s instructions and this Certificate.

13.2 Once mixed, further materials must not be added to the fresh concrete.

13.3 Concrete containing the product should be fully compacted.

13.4 Concrete containing the product should not be placed at temperatures of 5°C or below.

13.5 Concrete containing the product should be placed in the same way as plain concrete, in accordance with the Certificate holder’s health and safety guidance and the normal routine precautions for handling fresh concrete.

14 Curing

The concrete should be cured strictly in accordance with BS 8110-1 : 1997 and the Certificate holder’s recommendations where site specific information exists.

15 Joints

15.1 Joints should be designed with waterstops as recommended in BS 8102 : 1990, to maintain watertightness of the whole structure. The advice of the Certificate holder should be sought on particular applications.
15.2 Penetrations of the concrete, such as pipe entries or formwork ties, must also be securely sealed to maintain watertightness. The advice of the Certificate holder should be sought on suitable systems.

16 Finishes
When water-based products are used to coat the product, a bonding agent may need to be applied. For specific cases, advice should be sought from the Certificate holder.

17 Rendering
17.1 Rendering should be to BS 5262 : 1991 and BS EN 13914-1 : 2005. The use of Pudlo CWP in the render at the rate specified in section 9.5 will not affect the normal rendering procedure.

17.2 Application should be in accordance with the manufacturer’s health and safety guidance and normal routine precautions for handling cementitious renders.

Technical Investigations

The following is a summary of the technical investigations carried out on Pudlo CWP (Cement Waterproofing Powder).

18 Tests
18.1 Tests were carried out by the BBA to determine:
- characteristics of the components
  - specific gravities
  - particle sizing
  - pH of aqueous suspension
- fresh concrete
  - workability
  - wet density
- hardened concrete
  - compressive strength
  - flexural strength
  - modulus of elasticity
  - bond to steel
  - freeze/thaw resistance
  - sulphate resistance
  - drying shrinkage
  - wetting expansion
  - water vapour permeability
  - liquid water permeability
  - initial surface absorption
  - water absorption
  - capillary absorption
  - efflorescence
  - surface bond of other materials
  - leaching resistance
- render
  - water vapour permeability
  - impact resistance
  - impermeability to liquid water.

18.2 An examination was made of test data from independent laboratories relating to:
- compressive strength
- flexural strength
- dynamic modulus
- hardened density
- sorptivity
- liquid water permeability
- oxygen diffusivity
- chloride diffusion
- carbonation
- freeze/thaw
- drying shrinkage
- water absorption
- initial surface absorption
- electrical conductance
- capillary absorption.

19 Investigations
19.1 Data on the concrete made with this product were examined and assessed for:
- mix designs
- curing regime.

19.2 An assessment was made of the product’s:
- range of use
- durability
- requirements for surface finishes
- maintenance and repair requirements
- compatibility with other regular concreting materials.

19.3 A visit was made to an existing site where the product had been used.

19.4 The manufacturing process was examined including methods for quality control, details of quality and composition of the materials used.

19.5 A user survey was conducted to assess the performance of the product in use.

Additional Information

The management systems of David Ball Group plc have been assessed and registered as meeting the requirements of ISO 9001 : 2000 by National Quality Assurance Ltd (Certificate No 2899).
BS 12 : 1996 Specification for Portland cement
BS 1881-5 : 1970 Testing concrete — Methods of testing hardened concrete for other than strength
BS 3177 : 1959 Method for determining the permeability to water vapour of flexible sheet materials used for packaging
BS 5262 : 1991 Code of practice for external renderings
BS 5492 : 1990 Code of practice for internal plastering
BS 6073-1 : 1981 Precast concrete masonry units — Specification for precast concrete masonry units
BS 8000-2.1 : 1990 Workmanship on building sites — Code of practice for concrete work — Mixing and transporting concrete
BS 8000-2.2 : 1990 Workmanship on building sites — Code of practice for concrete work — Sitework with in-situ and precast concrete
BS 8000-10 : 1995 Workmanship on building sites — Code of practice for plastering and rendering
BS 8007 : 1987 Code of practice for design of concrete structures for retaining aqueous liquids
BS 8102 : 1990 Code of practice for protection of structures against water from the ground
BS 8110-1 : 1997 Structural use of concrete — Code of practice for design and construction
BS EN 206-1 : 2000 Concrete — Specification, performance, production and conformity
BS EN 480-5 : 1997 Admixtures for concrete, mortar and grout — Test methods — Determination of capillary absorption
BS EN 934-2 : 1998 Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions and requirements, conformity, marking and labelling
BS EN 13914-1 : 2005 Design, preparation and application of external rendering and internal plastering — External rendering
BS EN 13914-2 : 2005 Design, preparation and application of external rendering and internal plastering — Design considerations and essential principles for internal plastering
ISO 9001 : 2000 Quality management systems — Requirements
Conditions of Certification

20 Conditions

20.1 This Certificate:
(a) relates only to the product that is named, described, installed, used and maintained as set out in this Certificate;
(b) is granted only to the company, firm or person identified on the front cover — no other company, firm or person may hold or claim any entitlement to this Certificate;
(c) is valid only within the UK;
(d) has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective;
(e) is copyright of the BBA;
(f) is subject to English law.

20.2 References in this Certificate to any Act of Parliament, Regulation made thereunder, Directive or Regulation of the European Union, Statutory Instrument, Code of Practice, British Standard, manufacturers’ instructions or similar publication, are references to such publication in the form in which it was current at the date of this Certificate.

20.3 This Certificate will remain valid for an unlimited period provided that the product and the manufacture and/or fabrication including all related and relevant processes thereof:
(a) are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA;
(b) continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine; and
(c) are reviewed by the BBA as and when it considers appropriate.

20.4 In granting this Certificate, the BBA is not responsible for:
(a) the presence or absence of any patent, intellectual property or similar rights subsisting in the product or any other product;
(b) the right of the Certificate holder to market, supply, install or maintain the product; and
(c) the actual works in which the product is installed, used and maintained, including the nature, design, methods and workmanship of such works.

20.5 Any recommendations relating to the use or installation of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date of this Certificate or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future statutory, common law or other duty of care. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the installation and use of this product.

In the opinion of the British Board of Agrément, Pudlo CWP (Cement Waterproofing Powder) is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 01/3843 is accordingly awarded to the David Ball Group plc.

On behalf of the British Board of Agrément

Date of Second issue: 6th September 2005

Chief Executive

*Original Certificate issued 8th August 2001. This amended version includes change of product name, reference to revised national Building Regulations, subsequent text changes, change of product specification, and Certificate layout, increase in cement content specification and new Conditions of Certification.
Enclosure 6

David Ball Group Warranty
PUDLO Thirty Year Performance Warranty

Client:

Project:

Warranty No:

David Ball Group plc warrants that if, within 30 years of pouring concrete made with PUDLO Concrete Waterproofing Powder, the concrete permits passage of water beyond that indicated in the PUDLO technical data sheet (or other written performance specification given in writing by David Ball Group for the job in question) then David Ball Group plc will procure the repair as necessary of the defective concrete, free of charge, provided that:

1. The PUDLO has been stored, mixed and used by all trades and parties involved in accordance with the instructions for use contained in data sheets and other trade literature supplied by David Ball Group plc or its distributor: and

2. Any job specific recommendations by David Ball Group or its distributor have been complied with by all trades and parties involved.

3. This warranty does not cover any damage or penetration of water caused by fire, structural movement, acts of God or other causes that are not a direct consequence of the failure of the PUDLO to provide the waterproofing performance indicated in the data sheet provided for the product.

4. The liability of David Ball Group plc for breach of this or any statutorily implied warranty shall not exceed the price of the defective PUDLO admixture supplied and paid for and is limited to the direct cost of repair of the concrete. Any liability for indirect or consequential damages for breach of this or any other warranty express or implied is hereby expressly excluded.

5. This express warranty is in lieu of all other warranties express or implied, which are hereby excluded to the fullest extent permitted by law. Nothing herein affects the statutory rights of the consumer that by law cannot be excluded. No agent, dealer, or employee of David Ball Group plc has any authority to modify this warranty in any way.

6. This warranty shall be read in conjunction with the technical data sheet supplied to the customer, but in the event of any conflict this document governs and is governed by English law.

7. This warranty will commence on our receipt of the following:
   a) a Practical Completion Certificate
   b) a confirmation letter stating that the work has been completed to the satisfaction of the appointed site inspector or client representative (such as the structural engineers for the project), and
   c) payment for all goods supplied to the Project.

___________________________________   ____________________
For and on behalf of David Ball Group plc   Date
Enclosure 7

Insurance Backed Guarantee
Summary of Latent Defects Insurance for PUDLO Concrete Waterproofing System

Our insurers have over 23 years experience in providing insurance warranties to the construction industry in the UK. They are therefore well placed to provide you with comprehensive cover at competitive rates of premium.

Cover can be arranged either for an entire building, new commercial development, refurbishments or certain elements such as cladding, curtain walling, glazing, structural waterproofing.

What is Latent Defect?

A latent defect is one which remains undiscovered at the date of practical completion but manifests itself during the period of insurance by way of actual physical damage, Latent Defects Insurance is therefore a form of insurance that meets the cost of rectifying defects in materials or workmanship including errors or omissions in design or specification which are not apparent when the job is finished but which come to light later.

What are the Key Features of Latent Defects Insurance?

- 10 year non-cancellable cover
- Cover for defects due to faulty design, specification, workmanship or materials
- Available for new, recently constructed, partially completed and completed commercial and industrial buildings. Also for domestic extensions and conversions
- Insurers pay if physical damage occurs – there is no need to prove fault or resort to litigation
- Cover is freely assignable to any party with a financial interest
- Index linking of sum insured
- Automatic cover for professional fees, debris removal costs, compliance with European or other public authority requirements
- One-off single premium
Enclosure 8

Case Studies
Concrete in Concert

PUDLO concrete admixture and sealants from specialists, David Ball Group plc, have played a vital waterproofing role in the major extension and refurbishment programme currently in progress at London’s Royal Albert Hall, due for completion by 2004.

During the 24 month Royal Albert Hall contract, over 100m³ of ready mixed concrete modified with integral waterproofer - Pudlo CWP. was used by specialist frame and underground works contractors John Doyle Construction to ensure the waterproofing of perimeter walls, capping beams, lift shafts and floors. Throughout the contract David Ball Group also provided a general inspection service on site and supervision and advice at the Battersea production plant of ready-mix supplier London Concrete.

Designed to the specification of consultants, Building Design Partnership, the watertight concrete was required to meet stringent standards. Of the products then available that satisfied these conditions. PUDLO CWP was the material of choice.

According to John Doyle Construction's Technical Director, Peter Goring, the outcome was satisfactory. He says: "Very close attention is always given to the construction materials in use and the test procedures that prove their reliability and performance. But when you are working on a national monument like the Royal Albert Hall the sense of responsibility becomes more acute. That was certainly the case with this very high profile contract. The required watertight performance of the perimeter slab edges of the five underground storeys that formed the bulk of our work behind, and below the level of the hall's impressive South Steps took on added significance. Quality assurance, mix design and precise delivery and installation of the concrete were all pivotal to a satisfactory conclusion to the job as a whole. In this demanding area of our operations test results proved satisfactory and the Pudlo worked well. We were also assured by the presence of the admixtures specialists during and after installation."

David Ball Group also supplied Instacem Primer Latex as a bond coat and Instalastic as a sump sealant to the PUDLO modified concrete used in the building's drainage system and elsewhere.

**Contractor**
Royal Albert Hall Trustees

**Main Contractor**
Taylor Woodrow

**Contractor Concrete Structures**
John Doyle Construction Concrete

**Specialist Concrete Admixture & Sealants**
David Ball Group plc
**Watertight Underground Factory for BAE Systems**

PUDLO CWP was used to make the structure waterproof.

VERYARDS, the consulting engineers on the project, had to ensure that the below ground structure would be completely dry, conforming to BS 8007. This task was made more difficult by the fact that the site was a former marshland with a renowned high water table. PUDLO CWP was used in constructing the 2 metre thick concrete floor and walls positioned 3 metres below ground. PUDLO was chosen, not only for its waterproofing capabilities but also because of the compressive strength it brings to concrete. The floor and walls of the underground structure had to be extremely robust to sustain the weight of the machinery above it. The structure houses the autoclaves used to make the aluminium skin panels for the aircraft wings - each autoclave is 40 metres long and weighs 300 tonnes. The PUDLO system also allowed the contractors AMEC and Murraywood Construction to make time savings during the project. Airbus UK had already taken orders from customers for the new aircraft and therefore it was essential that the factory was built on time so that production of the new planes was not delayed. The PUDLO system is quicker to install than membrane or drainage waterproof systems and therefore construction times were minimised and the whole project timeline was maintained. BRC Special Products, the UK distributor for PUDLO, provided an on site engineer throughout the project to give technical support and advice. The PUDLO system included an insurance backed guarantee.

**High Level Performance From PUDLO Admixture System**

In order to ensure watertight conditions and meet the completion schedule for the internationally acclaimed Airbus project, products from David Ball Group were specified for BAE Systems assembly plant in Broughton.

The nation's leading aircraft manufacturer Airbus UK, a division of BAE Systems, recently expanded its operation by building a vast aircraft assembly plant in Broughton, North Wales. The plant will be used to manufacture the most modern and comprehensive aircraft on the market including the "double decker" A380 super jumbo. The size of the development has been on a huge scale. The site is 400 metres long, 200 metres wide with peak heights of 35 metres - the equivalent of 1 ½ full size football pitches. The development includes the largest below ground machinery base in the UK and in order to ensure its protection from water ingress

**Contractor**
AMEC

**Consulting Engineers**
Veryards

**Specialist Concrete Admixture & Sealants**
David Ball Group plc
PUDLO used to Protect Vauxhall Tunnel
The construction of a pedestrian tunnel beneath Vauxhall Bridge, using precast box culverts, required a high performance waterproofing and corrosion resistant solution in order to meet the aggressive saline soil conditions in the Thames tideway.

The client, St George Plc, specified PUDLO concentrated waterproofing powder from the David Ball Group to be used in the casting of the box culverts, with additional specialised joint sealants, to ensure a perfectly dry structure.

David Ball comments: "This tunnel project was actually quite complex. We were asked to assist the engineers with the waterproofing specifications at quite an early stage in the planning process - a dialogue that influenced both the design of the precast concrete mix for the subway's box culvert sections, and the actual installation of sections on site ".

PUDLO CWP was used in the casting process primarily as a waterproofing agent, but also as additional protection against the corrosive effects of the soil, as described in BRE Digest 363 Concrete and Concrete Products in Aggressive Ground. To ensure waterproofing of the tunnel installation, the David Ball Group's hDR waterstop was used for the spigot and socket connecting joints, which were further sealed on the inner face with INSTAFLEX PU25.

David Ball Group engineers were constantly on site to assist in the successful completion of the project, just one of the facilities which the David Ball Group offers. Mc Nicholas Construction chose to employ this service ensuring that the project was completed on time and with as little disruption as possible.

The tunnel is an underpass that extends the Lambeth Walk by linking the promenade and apartments of the St George's Wharf development with the frontage of the MI6 building downstream of the bridge. It was opened by the Mayor of London who commented. "This tunnel walkway will open up the river for the public on a stretch of waterway that has previously been inaccessible thereby making a valuable contribution to the wider renaissance of the South Bank."

The developer St George was awarded "Major Project of the Year" at the Quality in Construction Awards for the St George Wharf development. The development was praised as a textbook example of up-to-the-minute brownfield redevelopment.

**Contractor**
Mc Nicholas Construction

**Precast Units**
Tarmac precast

**Specialist Concrete Admixture & Sealants**
David Ball Group plc
Enclosure 9

PUDLO Brochure
Introduction

David Ball Group plc manufacture products to ensure watertight, reinforced concrete structures.

The structures can be water-retaining, such as swimming pools, reservoirs, waste-water treatment works and tanks. Or they can be structures that keep water out such as basements, tunnels and underground car parks. Waterproof concrete provides integral protection ensuring that structures are watertight and completely dry.

PUDLO cement waterproofing system

The system comprises PUDLO cement waterproofing powder, an integral admixture for concrete together with hDR WATERSTOP and INSTAFLEX PU25 MASTIC for construction joints.

Compelling reasons for using PUDLO cement waterproofing powder

- Quality assured system
- Proven performance
- Unrivalled track record
- Outstanding customer service and on-site support
- Expert advice
- Straightforward and cost-effective waterproofing solution
- Full warranties and guarantees
PUDLO concrete

PUDLO cement waterproofing powder is a BBA approved admixture that can be used to produce watertight, corrosion-resistant structures.

PUDLO is a hydrophobic and pore blocking admixture which alters the microstructure of concrete to stop water transport mechanisms and increase durability.

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

PUDLO reduces corrosion mechanisms within concrete and, as a result, increases structural durability. The system is suitable for use in aggressive and hostile conditions such as coastal defence areas and waste-transfer sites. PUDLO has been used successfully worldwide to provide protection against water ingress and corrosion, even in high exposure class environments.

<table>
<thead>
<tr>
<th>Typical Results</th>
<th>Control (no admixture)</th>
<th>PUDLO concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength 7 days N/mm²</td>
<td>33</td>
<td>52</td>
</tr>
<tr>
<td>Strength 28 days N/mm²</td>
<td>43</td>
<td>61</td>
</tr>
<tr>
<td>Water absorption 28 days % (BS 1881-122)</td>
<td>2.42</td>
<td>1.25</td>
</tr>
<tr>
<td>Water Permeability mm penetration (DIN 1048-5)</td>
<td>12.6</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Carbonation mm depth</td>
<td>4</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Chloride Diffusion m²/s⁻¹ x 10⁻¹³</td>
<td>2.05</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Microslides showing the reduction in water transport mechanisms due to the addition of PUDLO. White scale denotes voids.

Control concrete

PUDLO modified concrete

PUDLO performance

The modified concrete provides the waterproof, corrosion-resistant solution.

PUDLO cement waterproofing powder
- Increases the density of concrete by 1%
- Improves chloride resistance by 100%
- Reduces rate of carbonation by a factor of 4
- Improves surface finish and texture
- Increases strengths by a minimum of 10%

PUDLO outperforms any other waterproofing admixture.
Concrete Specification

The concrete mix is the same as normal concrete with the addition of PUDLO at a rate of 2% by weight of cement (this equates to 8kg per 1m³ of concrete). The concrete should contain a minimum of 350kgm³ of cement and the water/cement ratio should not exceed 0.4. The target slump should be 100mm (+/- 20mm).

PUDLO is added at the batching plant with an adequate mixing time of 15 minutes. The material is a non-toxic, odourless, dry powder and packed in 1kg, 2kg, 8kg and 25kg bags. The 8kg bags are soluble and disintegrate in the mix.

Screed and Wall Render Specifications

Floor screeds and wall renders are made using normal sand / cement mixes. PUDLO is mixed with the dry constituents at a rate of 3% by weight of the cement (this equates to approximately 0.75kg per 25kg cement). Full method statements for screeds and renders are available on request.
Our Service and Warranty

Technical expertise is provided throughout the project from design stage through to completion. No obligation help and advice is available to the specifier, contractor and concrete supplier.

The quality assured User Guide gives comprehensive details on how to correctly use and install PUDLO modified concrete and a technical manager will give on-site support prior to and during pours.

David Ball Group plc issue a 30 year company warranty (covering products used and installation) and an independent, insurance-backed guarantee is also available on request. All those involved in the project can be assured that a leak-free structure will be achieved.

Placing PUDLO Concrete

The quality assured User Guide gives comprehensive directions for pouring and placing PUDLO modified concrete and a PUDLO representative will carry out in-depth training on site. Particular instruction will be given on compaction and curing, how to form construction joints using hDR WATERSTOP and how to deal with service pipes and tie bolt holes.
Case Study 1

Working with Mott MacDonald and Duffy Construction, PUDLO was used in the construction of AIG’s new European headquarters in London. By providing an easy-to-use, membrane-free waterproofing system, contract costs were reduced and one month was knocked off the construction time. The two basement levels had to be completely watertight for document storage and housing electrical equipment.

Case Study 2

PUDLO is particularly useful where existing protrusions and features have to be worked around, as in the case of the extensive refurbishment of the Royal Albert Hall. PUDLO modified concrete was employed by Building Design Partnership and John Doyle Specialist Contractor to ensure the waterproofing of the 5 storey underground car park and utilities building.

Case Study 3

The Fulham Pools Leisure Centre, designed and built by Amec, contains an 8-lane competition pool, a 6-lane fitness pool and a teaching pool. The concrete mix design for the floor, walls, surface slabs and undercroft of the pool tanks utilised PUDLO waterproofing admixture, hDR WATERSTOP and INSTAFLEX PU25 MASTIC to provide a high performance, water retaining structure.

Case Study 4

PUDLO is used extensively on projects around the world. In Dubai, where ground conditions are exceptionally aggressive and saline, the admixture has been used on numerous sites including the Jumeirah Road development. Watertight construction was imperative for this exclusive residential and commercial development. PUDLO modified concrete was used to construct the large basement area designed for car parking facilities. The first membrane-free project in Dubai.
**BS 8102: 1990 – Code of Practice for the protection of structures against water from the ground**

**PUDLO** cement waterproofing powder produces **Type B structurally integral protection**. The grade will be determined by the thickness of the walls and floor slab. Structures can be designed to BS8007 or BS8110.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Basement Nature</th>
<th>Basement Use</th>
<th>Waterproof Performance</th>
<th>Size mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic utility</td>
<td>Car parking; Plant rooms (excluding electrical equipment); workshops</td>
<td>Some seepage and damp patches tolerable</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>Better utility</td>
<td>Workshops and plant rooms requiring drier environment; retail storage areas</td>
<td>No water penetration but moisture vapour tolerable</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Habitable</td>
<td>Ventilated residential areas including offices, restaurant, leisure centres etc</td>
<td>Dry environment</td>
<td>250</td>
</tr>
<tr>
<td>4</td>
<td>Special</td>
<td>Archives and stores requiring controlled environment</td>
<td>Total dry environment</td>
<td>300*</td>
</tr>
</tbody>
</table>

**Note 1**
The wall sizes are recommendations only – technical manager can advise on each project individually.

**Note 2**
Can achieve Grade 4 at 270 (this allows enough concrete cover to act as a vapour membrane).

**Note 3**
Grades 3 & 4 need ventilation.

**UNRIVALLED TRACK RECORD**

Underground art gallery – first UK project to use waterproofed, self-compacting concrete, winning Concrete Society Award for Innovation.

Zero leakage for water testing tanks – national R & D facility for specialist hydraulic and marine environment engineers, H. R. Wallingford.

Wimbledon Centre Court Stadium – using lightweight, watertight concrete the loading stresses were reduced by 50% at the prestigious sporting venue.

Front cover: AIG’s new European headquarters in London.
PUDLO concrete waterproofing products

**PUDLO CWP**: dry powder admixture for structural concrete and waterproof renders.

**hDR WATERSTOP**: hydrophilic polyacrylate elastomeric waterstop. Designed for the internal sealing of construction joints for cast-in-place concrete. hDR WATERSTOP expands upon contact with water to form a positive seal even in saline conditions. The waterstop will perform successfully under hydrostatic pressure and under both continuous immersion and wet/dry cycling. hDR WATERSTOP is manufactured in 10 metre lightweight, flexible coils of 5mm by 20mm wide dimensions, 100 metres per box.

**INSTALASTIC**: liquid-applied, seamless, flexible, waterproof coating which is abrasion-resistant, providing long service-life for extreme service class concrete structures. Supplied in 35kg units (comprising 25kg powder and 10 litres of liquid) one unit is sufficient to apply to an area of 10m² with two 1mm coats.

**INSTAFLEX PU25 MASTIC**: high performance, polyurethane single pack, multi-purpose sealant. INSTAFLEX can be used to provide a low skin formation that is fast cure, non-sag and moisture curing. An excellent adhesive for hDR WATERSTOP.

**PUDLO SCC**: extension of PUDLO CWP the admixture is specifically designed to produce high workability, easy to use, self-compacting concrete with the benefits of ultra-low permeability and exceptional surface finish.

**INSTACEM Primer Latex**: blend of acrylic polymer resins that can be used as a primer or sealer. The latex is applied to previously prepared substrate before the application of the cementitious repair material or as final coating. Supplied in 5 litre units, one unit is sufficient to apply to an area of 25m² with two coats.

**INSTAPRUF**: cement based, water-resistant, hard wearing, self smoothing floor topping. Supplied in 29kg units (comprising 25kg powder and 4 litres of liquid), one unit is sufficient to apply to an area of 3m² at 3mm depth.

**INSTACEM concrete repair**: specially formulated, pre-mixed cement powder. The material mixes readily with water to produce a non-shrink, water-resistant, repair material that hardens to give a high strength product.