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Membranes point the way to greener future

In an era of climate change and environmental extremes, the performance of waterproof membranes can be critical. These large sheets are used in a variety of ways, from roofing to geomembranes.

Functions are constantly being added, including: as a cooling factor in heat islands; in renewable energy generation; and for maintaining an airtight system in building facades. At the same time, chemical exposure can be high for geomembranes in lining pits and dumps. The traditional bitumen materials – which have been used for thousands of years – are still prevalent today, though membranes based on polymers (such as polyolefins, PVC and EPDM) are increasing their market share.

The European construction industry has been in decline since 2008, with figures from Euroconstruct showing total spend of €1444 billion in 2008, €1316bn in 2009 and an anticipated €1264bn in 2010. Jon Nash, head of strategic research at AMI Consulting, reviewed this data in a presentation at AMI's Waterproof Mem-

Despite the recent slowdown in the construction market, the prospect for waterproof membranes is on the rise. **Dr Sally Humphreys** reports

branes 2010 conference, which took place in Cologne, Germany in December.

Around 50% of construction was new build in 2010, and this is expected to grow by around 1% this year, according to the figures. Civil engineering has been sustained throughout this time by government expenditure. However, the fact that membranes tend to be used in new build means that they get little 'protection' from a stable 'repair and maintenance' market – as has been the case.

Fluoropolymer roofing membranes are used in a number of sports stadiums, including Johannesburg's Soccer City



Trelleborg's Elastoseal membranes have been used at Dubai International Airport

"We take the view that construction demand will decline by about 1% in 2011, and that supplies into the construction industry in 2011 will be 95-100% of 2010 sales," said Nash.

Russian construction

Iakov Zemanovich, director of consultancy NTC Gidrol-Krovlja, used data from sources such as Rosstat to assess the construction industry in Russia. Its GDP dropped nearly 8% in 2009, but began to rise again in 2010 by around 2%. The construction market fell by 16% in 2009 and a further 1% in 2010, leading to a 20% fall in the output of waterproofing materials in 2009 – at which time one-third of companies left the market.

In 2009, Russia produced around 454m sq m of waterproof membranes, of which it exported 58.6m sq m (around 13%). Two-thirds of these exports went to former Soviet republics, with most of the remainder going to the European Union (especially Baltic nations).

In the same year, 1.2% of its membranes were imported, with single-ply membranes comprising 75% of the quota. Finland supplied mainly bituminous products, and Germany and Switzerland supplied most polymer products.

Russian membrane production seems to have reached its lowest point in 2009, as Zemanovich sees rapid growth over the next few years – in production and consumption. Both are expected to grow by more than 10% in 2010. Production is estimated to reach 558m sq m by 2013 (a 25% growth since 2009), while domestic consumption should approach 500m sq m (20% growth).

Middle East production

In the Middle East, Polaris International has established a PVC and TPO waterproof membrane production plant in Bahrain with two co-extrusion lines. The company conducted market research in Saudi Arabia, which showed that bitumen still holds the main market share

at 25%, with PVC at 21% and other polymers such as EPDM and TPO at 21%, alongside liquid polyurethane systems (also 21%). The Arab Water Seal Company, which has supplied waterproofing to the United Arab Emirates since 1998, estimates that around 40% of the Middle East uses bitumen waterproofing, 26% is liquid applied, 20% is PVC, and 5% each is EPDM and HDPE. The remaining 4% goes to bentonite. The trend in the region is towards green building products and construction, including LEED (Leadership in Energy and Environmental Design) accreditation for new projects. The Princess Noura bint Abdurrahman University in Saudi Arabia is the largest new development with 38 buildings and at least three of these are aiming for gold LEED status.

Solar panels are being combined with waterproofing membranes using technology from companies such as Solar Integrated, which uses components from its parent company, Energy Conversion Devices (ECD). United Solar makes thin film laminates for this market and has annual production of 150MW: over 6m sq m has been installed worldwide. Integration into the membrane avoids adding the weight and wind load of conventional crystalline photovoltaic systems and an ETFE front cover protects the system. TDDK in Dresden is using this system to generate an average energy output of 677MWh/year on some of its factory roofs.

Heat savings

Trelleborg Waterproofing has looked at the environmental aspects of membranes, including their use in walls for waterproofing and air tightness (typically EPDM or PVC membranes) to conserve energy. The driver in Europe is the Energy Performance of Buildings Directive 2010/31/EU, which requires that all new buildings must be nearly zero energy by 2020. In the UK air tightness is now a specified test (Part L Building Regulations 2010).

Ronan Brunton, international business director, told delegates that polymeric membranes play an important dual role in conserving building energy: by protecting the insulation layer and structure from moisture; and by reducing energy loss through air tightness – such as around windows.

EPDM panels

The company supplies products such as EPDM roofing panels, which can be electro-bonded using the Centrix system from Afast. In this system, metal stress plates in the roofing support structure are activated by a magnetic induction system to heat them, which activates their surface coating and bonds the support to the membrane. The membrane panels are joined using hot bond vulcanisation or TPO thermofusion techniques.

Elsewhere, the company's membranes have been used for applications including Dubai International Airport and a ski resort in Norway.

Production equipment for membranes is a big investment. A typical reinforced geomembrane comprises one or more synthetic sheets coated or laminated to a fabric reinforcement. The inter-adhesive layer can be extruded on the top and underside of the fabric. Typically the amount of plastic used in coating is 200 to 500gsm according to machinery supplier Davis-Standard. A combination of two co-located extruders can extrude adhesive and bulk polymer simultaneously and the edge trim can be added back in to reduce waste and cut material use.

KraussMaffei Berstorff has looked at the different requirements for extruders, depending on the form in which the material is supplied to the membrane manufacturer. For example, a single screw extruder is sufficient for processing pre-compounded TPO and PVC pellets at a rate of up to 500kg/h, while a co-rotating twin screw extruder is needed for high output (over 1500kg/h) and direct compounding.

TPO advantage

TPO-based membranes are becoming widely used, such as in the Tempodrome in Berlin (supplied by Sika). LyondellBasell has compared TPO to other materials, and says that far less is needed – which can reduce transport and other logistical costs. (It estimates that 11 trucks of bitumen is equivalent to 4.5 trucks of PVC or EPDM, and just four trucks of TPO.)

It has good root resistance for green roofs and can be produced in light colours to reflect sunlight and cut building cooling costs.

"A white, sun-reflecting surface will keep the temperature profile close to the air temperature, providing the building owner with substantial energy

saving," said Karen Janssens, an industry manager for roofing and geomembranes at LyondellBasell.

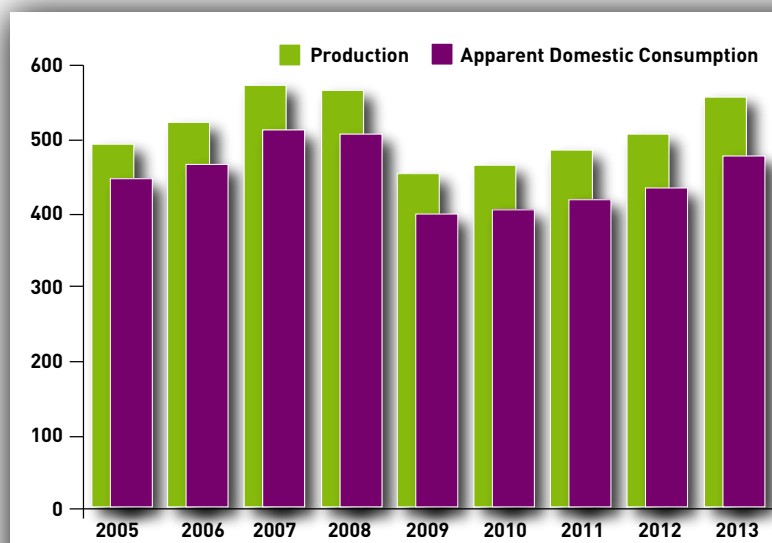
To reduce dust and dirt on the roof, a thin polypropylene film can be added by heat lamination – which was tested on a roof in Ferrara, Italy in 2009. The film had to be laminated to the TPO membrane economically, must be smooth and glossy, and not affect overall performance.

At the top of the range of roofing membranes are fluoropolymers. These are often used in transparent domes and other structures, an area where Hightex has expertise. In a project at Green Point Stadium in Cape Town in 2009, 27,000 sq m of PTFE-coated silver glass fabric was used, while in Johannesburg 50,000 sq m of the same structure was used in the Soccer City Stadium. Hightex currently has projects in the Olympic Stadium in the Ukraine, BC Place in Vancouver and the National Stadium in Warsaw. At the company office a pneumatic ETFE membrane incorporates flexible photovoltaic panels.

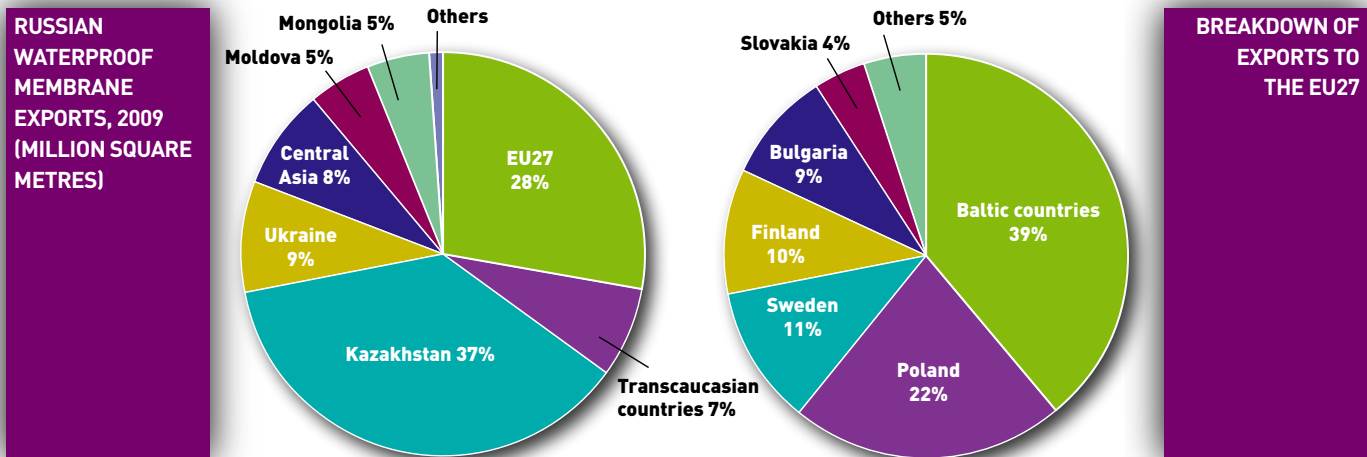
VOC reduction

Cynthia Teniers of Eval Europe has been studying the use of ethylene-vinyl alcohol (EVOH) copolymers to reduce volatile organic compound (VOC) loss through geosynthetics. Liners are used to protect the environment by containing liquids and vapour emissions. However, current monolayer membranes can permit VOCs to pass through, she said.

"Studies show that hazardous organic compounds diffuse through existing geomembrane liners," she said. "Inclusion of an EVOH barrier layer into select geomembrane designs will dramatically improve their barrier to VOCs."



PRODUCTION AND CONSUMPTION OF WATERPROOF MEMBRANES IN RUSSIA, 2005-2013 (MILLION SQUARE METRES)



If a 2-4% EVOH layer is added to a PE or PP membrane, or even to the clay liner, it can improve the barrier performance. During production of the multilayer polymer membrane an adhesive tie layer is needed.

Eval studied the permeability of different geomembranes – either with or without EVOH – to the common solvent toluene. A standard MDPE membrane showed a permeation rate above 60g/m² per day, while flexible PP was 1278g/m² per day. In each case, adding a 50 micron EVOH layer reduced this to the lowest limit of detection (0.005g/m² per day).

A field trial for an EVOH-enhanced landfill liner is ongoing at the Geosynthetic Institute in the US. Potential applications of these types of geomembrane include heap leach mining, oil sand tailing, concrete liners and biodigesters, said Teniers.

Liquid performance

H&R ChemPharm's new liquid applied super absorbent polymer system forms a film coating and embeds into the substrate.

It is currently in use in cables in a coated-yarn layer to protect optical fibres. The company has received enquiries from consultant geo-engineers about using this system in geomembranes as it blocks water and contaminants and is self-healing. The Technical University of Munich and Bolton Textile Institute have been studying the potential. The production method is simple – fabric is immersed in a bath of polymer and then pressed through heated rollers above 120°C before being rolled up.

Fire performance is a critical requirement of building materials. Warrington Fire Gent carries out fire testing to look at factors like flame spread. The standards which apply to roofing include ENV 1187 (CEN TS 1187) and EN 13501-5. Protocols include placing a basket of wood wool onto the roof construction test sample and flaming for 30 minutes with the roof at different angles.

Each European member state chooses a test method and level of safety.

The International Green Roof Association has highlighted the safety features for roofing including wind uplift, structural load bearing capability, fire regulations and drainage. It is particularly important to check the membrane joints and to test for leaks. A finished roof needs fall protection, which can be a rope and harness system for maintenance, or full fencing for a roof with public access. High rise gardens have been opened in Singapore and New York offering a park experience in the centre of the city.

In the late 1950s, Fatra produced one of the world's first PVC geomembranes for use in a dam in Dobsina. This Czech company now produces waterproof membranes for a variety of applications including ground waterproofing for new buildings, which need to act as a barrier against both radon and moisture. The advantage of synthetic membranes is their speed of installation, low labour cost, movement with the building (minimising tears and cracks) and high chemical resistance. However, they are thin compared to bitumen and can be torn during installation.

An active check system can be built in to show where leaks are occurring and to facilitate repair. It is much more critical to get ground waterproofing right first time, because of the difficulties of access and the consequences of failure.

The waterproof membrane market is growing worldwide and providing multifunctional components to the construction industry and aiding the move to LEED certification by incorporating cooling, gardens and alternative energy functions.

More information

The next AMI networking event for the industry, **Waterproof Membranes 2011**, is scheduled for 15-17 November 2011 at the Maritim Hotel, Cologne, Germany.