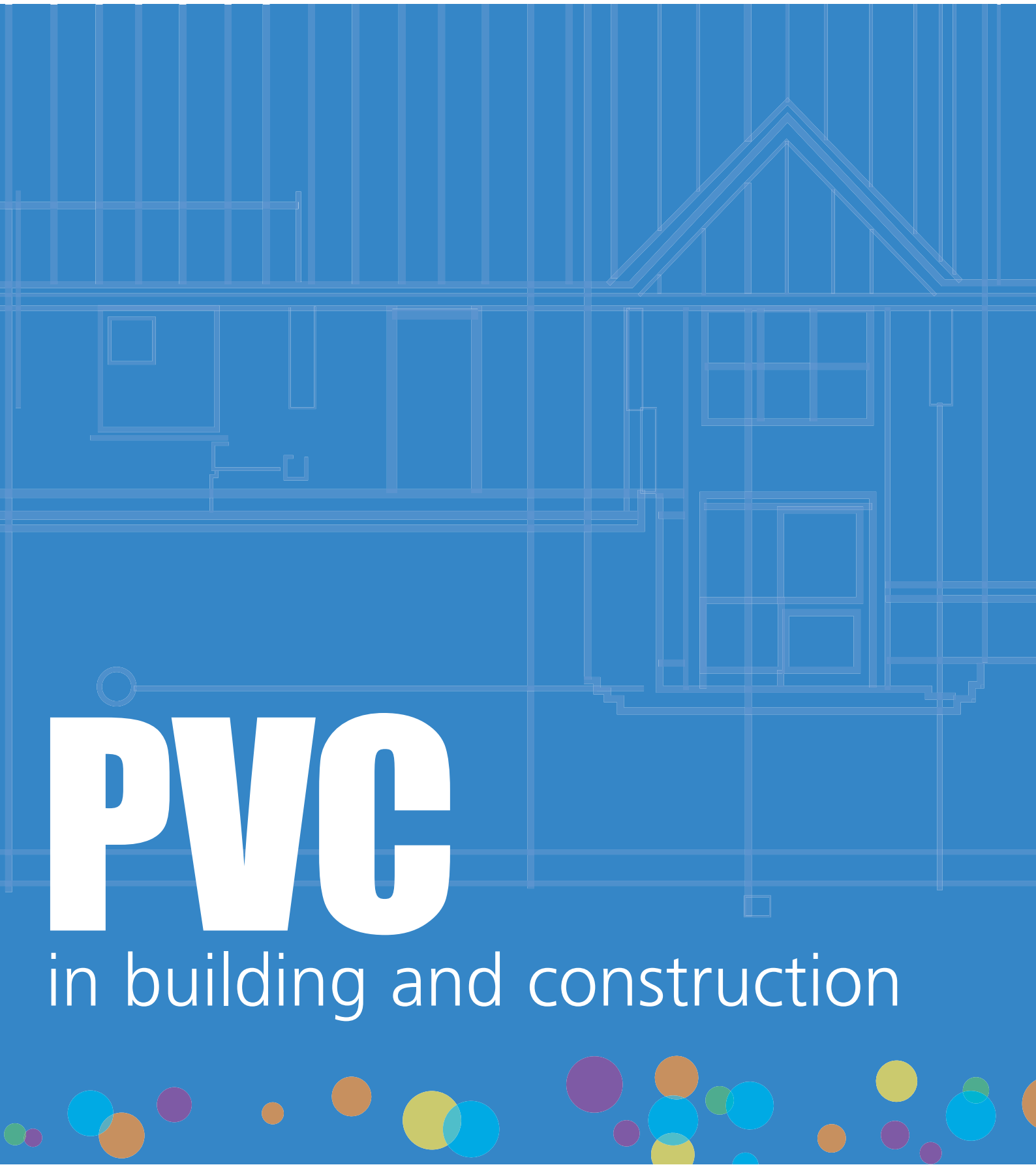
Vinyl Council Australia



PVC

in building and construction

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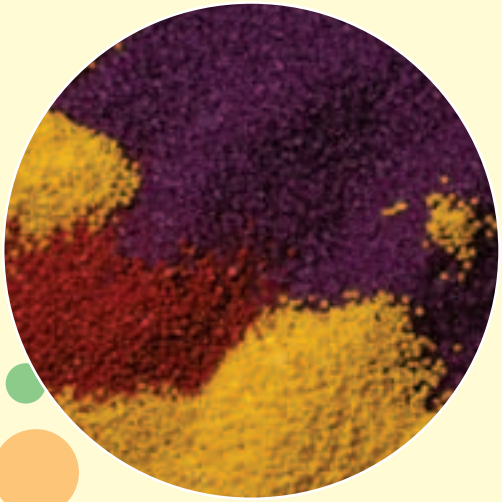

BIS Shrapnel has a ‘typical’

makes PVC important?

PVC makes a major contribution to the quality, safety and cost-effectiveness of construction materials, as well as helping to contribute to the sustainability of completed projects. PVC is the most widely used polymer in building and construction applications, which account for about 80 per cent of Australia's annual PVC production.

PVC has a versatility that helps it meet modern design needs. In addition to new projects, PVC is also widely used in refurbishment where it often replaces traditional materials such as clay and wood.

Key properties

Strong and lightweight

PVC's abrasion resistance, light weight, and strength are key technical advantages for its use in building and construction applications. Its use for light-weight structures such as roofing, is especially suited to building in Australia's tropical zone.

Easy to install

PVC can be cut, shaped, welded and joined easily in a variety of styles. Its light weight reduces manual handling difficulties.

Fire resistant

Unplasticised PVC is inherently difficult to ignite and stops burning once the source of heat is removed. Compared to its common plastic alternatives, PVC performs better in terms of lower combustibility, flammability, flame propagation and heat release.

Although plasticisers in PVC reduce its natural fire resistance, this is countered by the addition of flame retardants.

Newly developed PVC formulations (FR-PVC) have significant advantages in terms of lower acid emissions, smoke generation and enhanced fire resistance.

Cost-effective

PVC has been a popular material for construction applications for decades due to its physical and technical properties as well as cost-performance advantages.

Safe material

PVC is non-toxic. It is a safe material and a socially valuable resource that has been used for more than half a century. It is also the world's most researched and thoroughly tested plastic. It meets international standards for safety and health for both the products and applications for which it is used.

Good insulator

PVC does not conduct electricity and is therefore an excellent material for electrical applications such as insulation sheathing for cables. It also does not conduct heat or cold, providing thermal efficiency in applications such as window profiles.

Versatile

The physical properties of PVC allow designers a high degree of freedom when designing new products and developing solutions where PVC acts as a replacement or refurbishment material.

Its versatility is reflected in the wide range of consumer and building and construction applications it is found in, for example, automotive, packaging, interior design, clothing and fashion, billboards, marine, safety equipment and toys, as well as pipes, cables, windows and roofing.

estimated that it would cost an extra $2000-3000 to build Australian house if PVC were not used in its common applications.

Life cycle
and sustainability studies

PVC is probably one of the most well researched materials in terms of environmental credentials. At least 60 reputable life cycle assessments (LCAs) have been conducted on PVC since 1985. Nearly half of these have been related to building applications. The weight of evidence from these studies confirms that PVC's environmental credentials are sound compared to alternative materials.

There are usually no 'clear winners' in LCAs as all materials have strengths and weaknesses, but there are often some materials that perform worse in all life cycle impact categories. Assessments of PVC have never produced that outcome.

In 2000, The Natural Step (UK) completed an evaluation of the potential path to sustainability for PVC*, in which it said:

"There have been many life cycle analyses carried out upon various applications of PVC; probably more than for any other material. Inevitably they are of differing credibility. Some of the conclusions also appear to depend on whether the sponsor is an environmental pressure group or industry. However, the overall weight of them suggest that PVC is no more environmentally unacceptable/unsustainable than alternative materials, including 'natural' ones, in the short to medium term."

Cradle-to-grave review

In 1996, the CSIRO conducted a review of world-wide scientific research on the cradle-to-grave aspects of PVC in building materials: *The environmental aspects of the use of PVC in building products.*

The report was updated and expanded in 1998 and again in 2001, so that subsequent new research could be evaluated. The reports find that:

"There is little conclusive evidence, including LCA information available, that shows that PVC in its building and construction applications has significantly more effect on the environment than its alternative materials."[**]

More recently, the European Commission carried out a comparative LCA study on PVC.*** Published in 2004, the study found that PVC's environmental profile is no worse than that of the alternatives.

LCA References

Pipe/pipe systems

- Life cycle assessment of the manufacture of wastewater pipes, Specht et al, Ziegelindustrie International 4/1996, commissioned by the European Union for the Stoneware Pipe Industry [*stoneware, concrete, reinforced concrete, cast iron, PVC and HDPE*]
- Life cycle assessment of pipeline systems, EMPA (Swiss Materials Testing and Research Institute) 1998, commissioned by Verband der Chemischen Industrie (Chemicals Industry Assoc.), Kunststoffrohrverband (Plastic Pipe Assoc.) and Fachverband Steinzeugindustrie (Stoneware Industry Assoc.) [*PE, PVC, cast iron, stoneware*]
- Life cycle assessment of pipes in domestic sewage systems, Gerberit International AG 1998 [*cast iron, fibre cement, PVC, ABS, PP, PE*]
- Environmental life cycle analysis of gas distribution systems, University of Leiden 1996, commissioned by the Dutch Centre of Gas Technology [*PVC, PE, steel*]

Window Frames

- Ecological assessment of window structures with frames made from different materials (without glass), EMPA (Swiss Materials Testing and Research Institute) 1996 *[aluminium, steel, stainless steel, non-ferrous metal, wood/aluminium, wood, PVC]*
- Overall assessment of windows and frontages, Institut für Kunststoffprüfung und Kunststoffkunde (Institute for plastics testing and plastic science), Stuttgart University 1997 commissioned by Deutscher Verband der Fenster und Fassadenhersteller (German Association of window and frontage manufacturers) *[wood, wood/aluminium, PVC, aluminium]*

Floor Coverings

- Life cycle assessment study of resilient floor coverings, Fraunhofer Institute, International Journal of Life Cycle Assessment 2 (2), 73-80 1997, commissioned by European Resilient Flooring Manufacturers Institute *[PVC, polyolefine, linoleum, synthetic and natural rubber, polyamide carpet, parquet]*
- Life cycle assessment of flooring materials: case study, Chalmers University of Technology, Sweden 1997 Building and Environment Vol. 32, No.3 *[linoleum, PVC, untreated complete wood]*

PVC: an evaluation using the natural step framework, 2000, The Natural Step, UK.

**A discussion of some of the scientific issues concerning the use of PVC,* 2001, CSIRO

***Life Cycle Assessment of PVC and of Principal Competing Materials – Dr Martin Baitz, Johannes Kreissig, Eloise Byrne* PE Europe GmbH June 2004.

Environmental credentials

Relatively low energy content

PVC has a lower feedstock energy especially as compared to other polymers and common building materials. It is the least energy intensive of all thermoplastics. PVC resin manufacturing in Australia has achieved considerable energy savings and reduced greenhouse gas emissions over the past five years. The resin manufacturer, Australian Vinyls, received the 2001 Victorian Energy Award for manufacturing. Australian Vinyls and a number of the major PVC product manufacturers are signatories to Greenhouse Challenge.

Non-renewable resource use

More than 50% of PVC's feedstock is derived from salt, a renewable resource, which means that PVC consumes proportionately less non-renewable resources compared to other polymers and some common building materials.

Material efficiency

Through post-industrial recycling, there is very little resource wastage during the production of PVC and its conversion to finished products. Product development and innovation by Australian manufacturers is further improving design efficiency, optimising the use of PVC in products. Modified PVC (PVC-O) and oriented (PVC-O) pipes are such examples.

Thermal efficiency

Good thermal insulation properties of PVC windows and cladding help to increase the energy efficiency of buildings. PVC windows rated under the government-supported Windows Energy Rating Scheme (WERS) have consistently achieved the highest energy-efficient category – five stars.

Design for durability and long life

90% of PVC applications are designed for medium or long-term use. PVC is resistant to weathering, chemical rotting, corrosion, shock and abrasion.

In a recent study, PVC pipe that had been buried in Australian soils for 30 years was exhumed and its condition tested. It was found to be in excellent condition.*

In other uses, such as window profiles and cable insulation, studies indicate that over 60 per cent of the applications will have working lives of more than 40 years.

Low maintenance

Vinyl products such as flooring, wall coverings and windows require very little maintenance over their lifespans – a benefit both environmentally and economically. PVC windows and cladding, for example, do not require painting, thereby reducing potential emissions. Combined with durability, this makes for very useful and affordable products.

Indoor Air Quality

Materials that are synthetic or have been chemically treated in any way sometimes emit VOCs (volatile organic compounds) during installation, creating concern about the quality of air in buildings.

While this can also occur with vinyl products designed for building interiors, such as flooring, the VOC levels fall off significantly shortly after installation.

Testing on vinyl flooring products has shown total VOC emissions to be well within European standards (there are currently no equivalent Australian standards). The industry has been responsive to concerns about air quality in buildings and low VOC vinyl flooring is now available.

Health and safety

PVC is lightweight and easy to install in most of its applications. These factors offer occupational safety advantages over some traditional materials such as cement, stoneware and ductile iron. PVC's light weight also means less energy is expended in transportation.

Minimal pollution

PVC is produced in Australia under environmentally acceptable manufacturing methods and well within international guidelines for PVC manufacturing. Emissions are low and the manufacturer publicly provides information on its environmental performance through annual community reports and corporate environment reports at **www.av.com.au**. PVC manufacturing in Australia is not a source of dioxin emissions.

Recycling

While little end-of-life PVC is available from its building and construction applications in Australia, as most is still in service, PVC is recyclable and there are many recycling programs for PVC in Australia. For example, PVC is collected from scrap electric and telecommunications cabling and recycled into products such as shoe soles and hoses. Kerbside collected PVC bottles are recycled into locally manufactured flooring and pipe fittings. New pilot projects are exploring the collection and recycling of PVC pipe offcuts and locally manufactured flooring installation waste directly from building sites.

PVC products available with recycled content include:

- commercial floor coverings
- stormwater pipe and fittings
- plumbing DWV (drain, waste and vent) pipe
- roadside guideposts

At the end of a PVC product's useful life, if not recycled, it can be safely incinerated or deposited in landfill.

*Long-term performance of PVC pressure pipes, 2000, CSIRO.

Uses

of PVC in building and construction

Pipes and conduit

Pipes are the major application for PVC in construction, accounting for 63% of PVC products in Australia.

PVC pipes possess excellent material qualities. In a range of applications from gutters to sewerage pipes and pressure pipes to cable conduits they are able to meet demanding specifications. They are extremely durable, cost-competitive, easy to install and require low maintenance. They are corrosion and abrasion resistant, and lightweight.

PVC has very good chemical resistant properties and can be used above or below ground to conduct many substances including oil, drinking water and gas. PVC pipes are also used as ducting (conduit) in the telecommunications and electricity industries, safely housing cables and wiring.

The extrusion process, plus the fact that PVC is light in weight, allows long sections of pipe to be used, minimising the number of joints. This reduces the cost of assembly and the risks of leakage common with some other materials.

PVC pipe has been in use in Australia for over 40 years, replacing vitreous clay as the material of choice in the sewer, storm, drain and DWV markets over the last 25 years, and for good reason: PVC pipe and its jointing systems are resistant to tree root penetration which causes blockages and cracking. PVC liners and inserts are often used to repair damaged concrete or clay pipes.

In the field of water supply, PVC is the material of choice for reticulation of potable water in all our major cities and regional centres because of its excellent performance and cost effective installation compared to other pipe options.

The Water Services Association of Australia (WSAA) gives all PVC pipe systems a Category A rating, signifying a life expectancy of over 100 years.

PVC is now used in 95% of the domestic house drain market in Australia, being durable, light and easy to install. It also has the advantage of being a poor conductor of heat or sound.

All the major building and construction applications for PVC pipe can be sourced locally. Pipe makers in Australia use post-industrial PVC waste and some post-consumer PVC waste (such as kerbside collected bottles) to replace virgin PVC in some new pipe products, such as stormwater pipe and fittings, conduit and plumbing DWV pipe.

Advances in PVC pipe materials

Recent innovations in pipe manufacture have led to the availability of new products such as oriented PVC (PVC-O) and modified PVC (PVC-M) pipes.

PVC-O: This product is made by re-aligning the PVC molecules through a process of bi-axial orientation. This greatly enhances the material properties – around twice the strength and ten times the impact resistance is achieved compared to traditional PVC material.

It means the wall thickness of PVC-O pipe can be reduced by up to 50%, while maintaining the same pressure as that of traditional PVC pipe. The result is that PVC-O has a larger bore

Resisting tree root intrusion

The CSIRO conducted trials comparing the resistance of clay, concrete and PVC pipe joints to tree root penetration, under accelerated conditions over 32 months. Whereas PVC showed no attack by tree roots, there was severe attack on the other pipes, both through the joints and the pipe wall, with joints actually being broken.

Tree root penetration of pipeline systems can result in seepage into pipelines, flooding of sewage treatment plants and sewage leakage out of pipeline systems. PVC pipes will protect against this.

offering greater hydraulic capacity, the pipe is manufactured using significantly less embodied energy and it is more material efficient compared to other pipe options.

Although PVC-O pipes have been produced and used in Australia for nearly 20 years, recent manufacturing advances have seen greater availability in the last five years. These significant manufacturing advances are genuinely Australian developments.

PVC-M: Modified PVC is an alloy of PVC. An impact modifier has been added that improves the fracture toughness of the material.

This enhanced toughness enables PVC-M to be manufactured with a thinner wall, with subsequent material savings and improved hydraulic properties.

PVC-M was introduced to the UK water industry about ten years ago and to South Africa shortly after. PVC-M pipes were first produced in New Zealand in 1996 and have been used in Australia since 1997.

Wiring and cable sheathing and insulation

PVC has been used as sheathing for cables for many years in Australia and accounts for around 50% of the Australian power cable market. PVC cables are general-use products found in commercial buildings and domestic residences.

PVC is durable and has good electrical properties which can be tailored for high/low temperature service and flexibility. These are some of the reasons why it is used in insulation and sheathing of power and telecommunication cables. In a less flexible form, PVC is also extensively used for cable conduit.

Other benefits PVC brings to cable include its flame retardant properties, relatively low cost, its ease of processing and over 50 years of manufacturing history. PVC cables have been proven to have a long life performance. In Australia cable is further recycled when it reaches the end of its life.

From cables to shoe soles

It is estimated that about 10,000-15,000 tonnes of electric cable waste is generated every year in Australia. Cable waste is recycled in Australia for the valuable metal content. At the same time, the shredded PVC sheathing is retrieved and recycled. In Australia, more than 2,000 tonnes of this PVC is recycled into products such as shoe soles and mud flaps each year.

Uses

of PVC in building and construction

Cladding and roofing membranes

PVC cladding is designed as a long life product requiring no painting and little maintenance. PVC's durability, high thermal insulation and excellent weathering performance (good resistance to UV light and ozone), mean that cladding can remain in place for many years.

While in overseas markets, especially the US, PVC cladding is a popular choice for both renovating old homes and building new, in Australia it has traditionally been used for refurbishing older homes. Its low up-keep requirements and durability, however, suggest its potential as an affordable housing option.

PVC roofing membranes are easy to install, highly waterproof and require little maintenance. They are naturally fire retardant, have long service lives and can have dirt-resistant coatings. PVC membranes are typically reinforced with a woven fabric such as polyester or glass fibre, making them extremely durable. They can provide as much as 80% solar reflectivity reducing building air-conditioning demand and 'heat island effects'. As light weight structures, they offer excellent characteristics for Australian climatic conditions.

A good quality membrane can be highly effective in preventing water and root penetration, so are now often specified in 'green' or living roof systems.

Floor and wall coverings

PVC is the main plastic used for sheet and tile flooring. Over five million square metres of vinyl floor coverings are laid in Australia each year.

PVC resilient flooring is widely used in Australian hospitals, sporting clubs and commercial kitchens where slip resistance and high levels of safety and hygiene are required. It is hardwearing, warm underfoot, cost-effective and easy to keep clean as it has a pore-free surface. Vinyl floors are low maintenance, hygienic and fire resistant. PVC sheet flooring can be heat welded to form an impervious barrier to water and moisture.

In design terms, PVC floor coverings are available in a wide variety of colours and finishes, making them adaptable for educational, hospital, residential or commercial applications.

Vinyl coated wallpapers offer durable, washable wall coverings. They are long lasting and available in a wide range of colours, patterns and textures.

Window and door profiles

One of the major uses of rigid PVC (or uPVC, meaning unplasticised) in construction in Europe and the US is profiles for windows and doors. The PVC window market in Australia is only more recently being developed.

2001 Winter Olympics Ice Oval

A single-ply PVC membrane was the material chosen to roof the Salt Lake City Winter Olympics Ice Oval, a recent project that presented interesting challenges to the designers and builders. Ice ovals for elite-level sports events require particular interior air and temperature dynamics to prevent 'hot spots' from developing and warming patches of the ice arena. Five acres of white, reinforced PVC membrane were mechanically attached to the roof structure. It provided high solar reflectivity, which contributed to the building being able to maintain a constant, optimum air temperature at ice level, even with a full audience present. The membrane was also ideal for printing the Olympics logo on.

Sydney Airport floor

11,000 square-metres of specially designed and locally produced vinyl flooring was laid in the refurbishment of Sydney Airport's international terminal, in time for visitors of the 2000 Olympic Games. The hard-wearing, low maintenance flooring in the Airport's International Arrivals Hall, including the heavily trafficked baggage claim area, withstands tough treatment from the 7,000 passengers – and their luggage – estimated to pass through the upgraded passenger terminal each hour.

In Europe, some 40 per cent of all window profiles are made from PVC. Specifiers and consumers choose PVC windows because they are tough and durable, require low maintenance, do not rot, offer design flexibility, are competitive in terms of price and can be easily processed and fabricated. Double-glazed PVC windows offer excellent thermal and acoustic properties, qualities which are now increasingly recognised in urban developments in this country.

The main alternatives to PVC for window frames are wood and aluminium. Traditional metal window frames conduct heat and cold, reducing thermal efficiency. Although timber frames are good insulaters, they weather and require a lot of maintenance. Various eco-balance studies undertaken internationally have shown that PVC has an ecological balance as good as or better when compared to alternative materials used in window profiles. PVC windows consistently rate five stars, the highest category under the Australian Window Energy Rating Scheme.

In Australia, PVC windows have been installed in a range of residential home designs and apartment buildings and are particularly beneficial near the sea due to their non-corrosive properties.

Photo courtesy of Armstrong World Industries (Aust) Pty Ltd

Safety and performance for sports

Over 23,000 square metres of PVC sports hall flooring was laid for the Sydney 2000 Olympic Games at 65 courts in the Sydney Olympic Park facilities. Volleyball, handball, table tennis and badminton were played on the durable surface in a special range of colours developed for the Australian games. PVC flooring was selected because it combines shock absorption and safety features without compromising the performance of the players.

Protection in tough conditions

Energy efficiency and maintenance were key concerns for Joe and Frances Walkerden when they built a straw bale house at Torquay on Victoria's coast – an area exposed to plenty of sun, wind and salt. They chose to install PVC windows.

"The issue of transference of heat was a real one for us," Mr Walkerden said. "But so was maintenance and cleaning, particularly in this harsh climate. So we were pretty happy to find the solution in these windows."

PVC
in architecture and design

PVC is a versatile and adaptable material with suitable specifications to meet modern and future design needs. Modern architects often turn to the material in their search for innovative solutions to building design challenges.

From the use of tensile roofing structures to provide air and light, through to the specification of replacement window systems in building renovation projects, PVC provides the material – architects provide the inspiration.

Invoking the spirit of Australia

When the designers of the Australian pavilion for the World Expo 2000 in Hannover, Germany, were looking for a building material that was easy to use, economical and matched the Expo's theme of environmental harmony, they settled on vinyl.

Sydney architects, Tonkin Zulaikha designed the pavilion to evoke the spirit of Australia at an abstract level. More than five thousand square metres of desert-red coloured vinyl was wrapped around prefabricated steel to create a stunning pavilion whose imagery reflected the textures and form of the Australian landscape.

Free standing curving walls and a large floating roof, all made of two layers of vinyl, helped create the feeling of an ambiguous relationship between inside and outside. The Australian pavilion was so well received, it was a feature of the Expo 2000 website.

Voluntary Product Stewardship Commitment of the PVC industry

Like the European industry, the Australian PVC industry has cooperatively developed an industry-wide voluntary agreement on a set of environmental commitments, called the Product Stewardship Commitment. The Initiative was developed in conjunction with Environment Australia, and launched by the Federal Minister for Environment and Heritage, Dr David Kemp MP.

Its aim is to document publicly commitments that address issues of concern in the PVC life cycle. The Commitment was signed by 33 companies and members of the Vinyl Council of Australia in November 2002.

The commitments in the initiative address:

- Targeted phase-outs of toxic heavy metal stabilisers;
- A policy on the safe use of phthalate plasticisers;
- Post-consumer and building waste recycling;
- Emissions in resin manufacture;
- Public reporting and research.

The Product Stewardship Commitment binds the signatories to deliver specific outcomes in set timeframes. A Technical Steering Group, comprised of industry, government and independent technical experts will oversee progress against the commitments. Progress will be reported publicly on a yearly basis.

Through the Product Stewardship Commitment, the industry is working to reduce further the environmental impact of PVC manufacture and expand options for sustainable PVC waste management in Australia.

Further information on PVC in building and construction applications can be found on www.vinyl.org.au and www.vinylbydesign.org

PVC Product Stewardship Commitment

the material –
architects provide the inspiration.

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