Off-form Concrete

Specifying plywood formwork
for high-quality decorative finishes

BigRiver

“A high-quality concrete finish requires high-quality formwork materials… Lower-grade materials may be used only if the surface finish is not critical.”

Introduction

For structures where the concrete will be visible after completion, the off-form concrete finish must be properly specified and considered at the outset. To achieve a high-quality finish, considerable attention needs to be given to a range of factors, including the concrete mix, formwork materials, detailing and sealing, and industry best practice.

Failures relating to off-form concrete finishes are often connected to the quality and grade of the formply product provided, as well as the type of finish specified and how the formwork product was used. The effects of weather exposure on formwork, if not properly mitigated, can also lead to an off-form finish that does not meet expectations.

To avoid such issues, architects, designers and specifiers need to be aware of the relevant considerations that go into specifying an appropriate off-form finish under Australian standards, how formwork materials impact the concrete surface finish, and the relevant considerations when selecting formply products. Below we explore these topics in more detail.


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What is off-form concrete?

Due to its strength and durability, concrete is a widely used material for many different types of construction. It can be used to create any type of structure, including the floors, walls and roof of residential and commercial buildings, or for non-structural applications. It can be shaped to form anything from kitchen islands and built-in seating to steps, benches and rampways.

In order for concrete to set into the desired shape for architectural use, it must first be poured into a temporary mould known as “formwork”. Concrete that is poured into open-topped forms that are later removed after it has set is known as "off-form concrete".

Formply is a structural plywood product that is mainly used for formwork. It holds and protects concrete until it sets after which the formply can be stripped (or removed). Formwork not only gives concrete its shape, but it also, to a large degree, determines the quality of the concrete surface after it is removed from the mould, also known as the “off-form finish”.

Specifying the right off-form concrete finish: AS 3610

Off-form concrete gives architects, designers and specifiers the opportunity to specify the type of surface finish required for a structure. AS 3610 “Formwork for concrete” provides the format for communicating concrete finishing requirements to the project team.

Table 3.2.1 of AS 3610 defines the characteristics of the surface classes, with five classes of finish, where Class 1 is the highest standard and Class 5 the lowest. This Table is reproduced below.

	Class 1 (see Note 1)	Class 2	Class 3	Class 4	Class 5
	Visual quality important			Visual quality not significant	
Visual characteristics	Highest quality attainable Subject to close scrutiny Best possible uniformity of texture Excellent quality of edge and joint details	Uniform quality and texture over large areas Built to close tolerances Consistently good quality to edge and joint details	Good visual quality when viewed as a whole	Texture not important Good general alignment	Alignment and texture not important
Suitable uses	Selected small elements contained in a single pour Areas of special importance in limited quantities	General external and internal facades intended to be viewed in detail	General external and internal facades intended to be viewed as a whole	Surfaces concealed from general view Surfaces to have thick applied finishes after preparation	Totally concealed areas
Surface treatment	Not applicable	Reference shall be made to acceptable surface appearance and measurable deviations prior to surface treatment			Not suitable
Situations where not to be used	Trafficable slopes, soffits, formed tops of slopes except where means to dissipate entrapped air are employed, form liners. Not applicable where treatment is to 100% of surface	Formed tops of slopes except where means to dissipate entrapped air are employed	No restriction		
Colour control	May be specified. Refer to Clause 3.5.3(b) for the limits of the best colour consistency that can be expected			Excluded	
General	If Class 1 and Class 2, Class 3, Class 4 and Class 5 are required they shall be specified in the project documentation		If Class 1 and Class 2, Class 3, Class 4 and Class 5 are not specified in the project documentation, selection of appropriate class shall be by the visual characteristics and suitable uses set out above		

NOTES:
- 1 Class 1 is the highest standard with the most rigorous specification and is only recommended for use in very special features of buildings of a monumental nature. Class 1 shall not be specified for whole elevations or extended surface areas.
- 2 Different methods of forming elements and repair may affect the texture of the surface finish. It is essential that test panels take this into account.

Table 3.2.1 Applicability of Surface Classes. Source: AS 3610

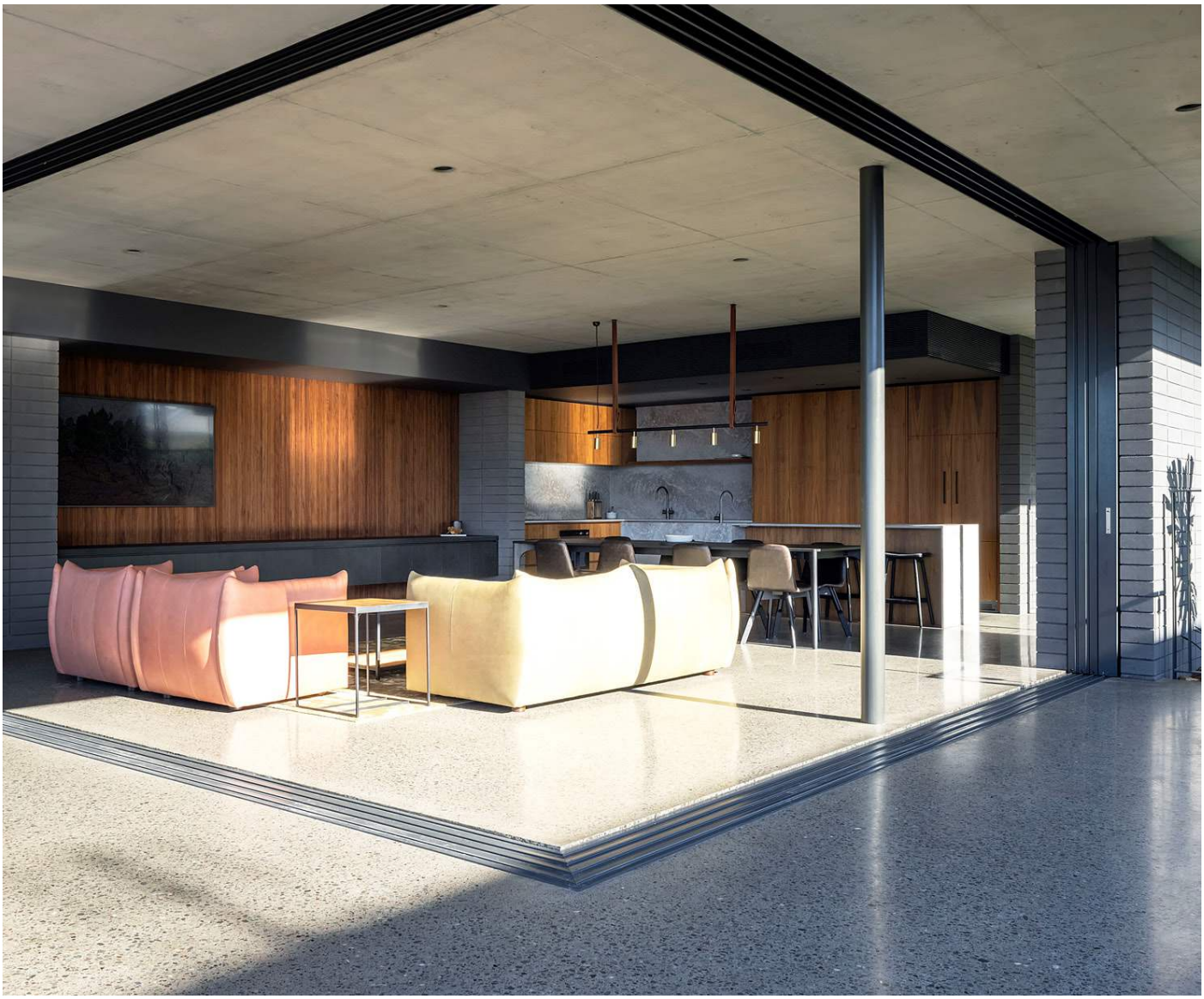
Improper use of AS 3610 poses a significant risk for building projects. If an off-form concrete finish is incorrectly specified or if finishes are confused, it is likely the final structure will not meet the designer or client’s expectations. To avoid such issues, it is important to have a thorough understanding of the Standard’s intended scope and be realistic in terms of what can be achieved given a project’s timelines and budget.

A common mistake is incorrectly specifying Class 1 finishes for a project.[1] Class 1 is the highest standard with the most rigorous requirements for inspection. AS 3610 allows specification of Class 1 only for special features of buildings of a monumental nature, small elements and elements contained in a single pour.[2] Accordingly, Class 1 should not be specified for facades, extended surfaces, structural units, or any other instance not specifically mentioned in the Standard.[3] In fact, a Class 1 finish will be impossible to achieve in all but a small number of specific applications.[4]

A Class 2 or 3 off-form finish is appropriate for most architectural applications. Class 2 is a high-quality finish that is intended for external and internal facades that can be viewed in detail.[5] The main differences between Class 2 and 3 are the type, number and dimensions of permitted surface defects.[6] In many cases, Class 3 is an acceptable standard for many industrial and civil structures where visual appearance is still important and is more cost-effective.

Classes 4 and 5 apply to surfaces that are hidden from public view or are never seen in situations when the visual quality is not significant.

Another common mistake with AS 3610 is calling for a class of finish for off-form concrete when exposed aggregate is specified. Note that AS 3610 applies only to off-form surfaces, and not surfaces treated with a secondary finishing technique such as polished, honed, grit (sand) blasted, acid etched and other such architectural finishes.[7]



How formwork materials impact surface finish

A high-quality concrete finish requires high-quality formwork materials. There are a range of materials (plywood, timber, steel and so on) that may be used to achieve different types of finishes, from patterned to smooth textured surfaces. Lower-grade materials may be used only if the surface finish is not critical.

Formwork materials must be chosen with respect not only to the desired surface finish, but also to provide sufficient stability to withstand the expected loads during erecting and concreting. A lack of strength and stiffness may lead to bowing and warping, or deflection during concrete placing and compaction, which will then lead to defects and variations in the off-form concrete finish.[8]

The absorbency and watertightness of the formwork material will also impact the appearance of the concrete. An absorbent formwork material like timber that has not been properly treated and effectively sealed may absorb moisture from fluid concrete, causing variable thickness swelling within the material.[9] This can result in discolouration, pronounced grain patterns and hydration staining on the concrete's surface. Formwork material that has low and uniform moisture absorption is essential to achieve a uniform colour on the concrete's surface.[10]

Formply, which is a type of specially engineered plywood, is an ideal material for formwork as it offers rapid fixing, large surface areas without joints, resistance to impact, and resistance to moisture shrinkage and swelling.[11] It benefits from a special plywood lamination process and facings of phenolic resin impregnated paper that give it extra durability, strength and low moisture absorption when compared to conventional construction plywood or timber.

Release agents are required for most formwork materials on surfaces that are in contact with the concrete. Their primary function is to enable an effective release but can also improve impermeability of the formwork's surface and, ultimately, the appearance of the concrete finish. The use of appropriate concrete, correct release agent and effective concrete placing techniques are important for minimising blow holes.[12]

Considerations when selecting formply

AS 6669:2016 “Plywood — Formwork” specifies requirements for the manufacture, grading, finishing and branding of plywood used specifically in formwork, intended to meet off-form surface finish requirements. This Standard includes specifications for the quality of the outer surface; bond quality and durability; thickness, length, width and flatness at the time of manufacture; stress grading and other structural properties; quality of the overlay; water permeability; and alkaline resistance.

Formply is usually sold on the basis of surface class, stress grade and bond quality. For example “Class 2 F17 A Bond” indicates that the formply product is intended to provide a Class 2 surface finish, has a stress-grade of F17 and has a Type A bond.

Bond

AS 6669 specifies three bond types—A, B and C— to cover bond durability requirements for formply across a range of applications and re-use conditions. Type A bonds are manufactured from phenolic adhesives and are durable for 50 years of weather exposure. Type B bonds are melamine fortified urea adhesives, which are durable for 2-5 years of weather exposure and suitable for most frameworks that are rarely exposed for periods in excess of 2 years.[13] Type C bonds are urea-formaldehyde with durability for 1-2 years weather exposure.

In general, formply manufactured in Australia is Type A or Type B bond.[14]

Stress grade

A reliable prediction of the plywood panels' strength and stiffness is made possible by stress grading, which establishes the allowable working stresses and elastic moduli of the material. AS 2269 “Plywood — Structural” specifies the methods for determining stress grades.

Stress grades for plywood in general are designated by a capital F, followed by a number. While stress grades for plywood range from F7 to F34, the most common stress grades for formply are F17, F22 and F27.

The appropriate stress grade for a project will depend on the budget and structure of the building. Note that it is unrealistic to use a lower grade of formply and expect a higher-quality off-form finish.

Surface class

Four surface qualities—Class 2, Class 3, Class 4, and Class 5—are defined by AS 6669. These surface characteristics follow the classifications in AS 3610.

> “Formply benefits from a special plywood lamination process and facings of phenolic resin impregnated paper that give it extra durability, strength and low moisture absorption when compared to conventional construction plywood or timber.”

Effects of weather exposure on formply

Not all formply products are the same; some are more durable than others. One area where this is most evident is how different formply products perform when exposed to variable weather conditions.

The phenolic surface film that is characteristic of formply is not waterproof, but rather slows the uptake and release of moisture. In the right conditions, moisture can penetrate through the surface film, leading to moisture ingress and swelling along the formply sheet, which in turn causes bowing and twisting.[15] Grain raising is also caused by moisture penetration.[16]

If the change in moisture content is too high, bowing and twisting will be unavoidable regardless of the quality or grade of the formply. Weather conditions that involve very hot daytime temperatures followed by heavy rain are particularly challenging for most formply products.[17]

Choosing a higher stress grade with a heavier grade of phenolic surface film and a thicker face veneer can mitigate some of these effects when severe weather exposure is expected.[18] Formply can be produced with heavier overlays that are less permeable to moisture. Thicker formply (19mm or 21mm) with thin face veneers (1.0mm or 1.5mm) are also less prone to distortion.[19] In addition, good site practices, such as tarping any formwork during wet weather and avoiding ponding of water, are a necessity.

Big River ArmourForm—The world's most durable formply

ArmourForm F27

ArmourForm F27 (green edge) total hardwood formply has a high-density phenolic overlay, ensuring more concrete pours and thus greater value. This premium quality, new generation formply is designed and manufactured for fixed formwork applications—tableforms, jumpforms, shutters, heavy civil engineering and mining applications.

- Superior spanning capabilities
- Can achieve 40 plus castings with proper on-site care
- Class 2 finish

ArmourForm F22

ArmourForm F22 (grey edge, red stripe) formply is constructed from a mixture of hardwood and pine veneers with a high-density phenolic overlay. This versatile formply can be used in all applications, such as tableforms, shutters, columns, conventional and system formwork.

- High quality off-form finish
- High strength-to-weight ratio
- Class 2 finish

ArmourForm F17

ArmourForm F17 (grey edge, yellow stripe) formply is constructed from mixed species veneers with a hardwood face and phenolic overlay. ArmourForm F17 is highly durable and ideal for general formwork use such as decks, precast and tilt-up panel construction. With proper on-site care and installation, a high quality off-form class 2 finish can be achieved.

Bending Ply

Formply manufactured for curved formwork and relining shutters.

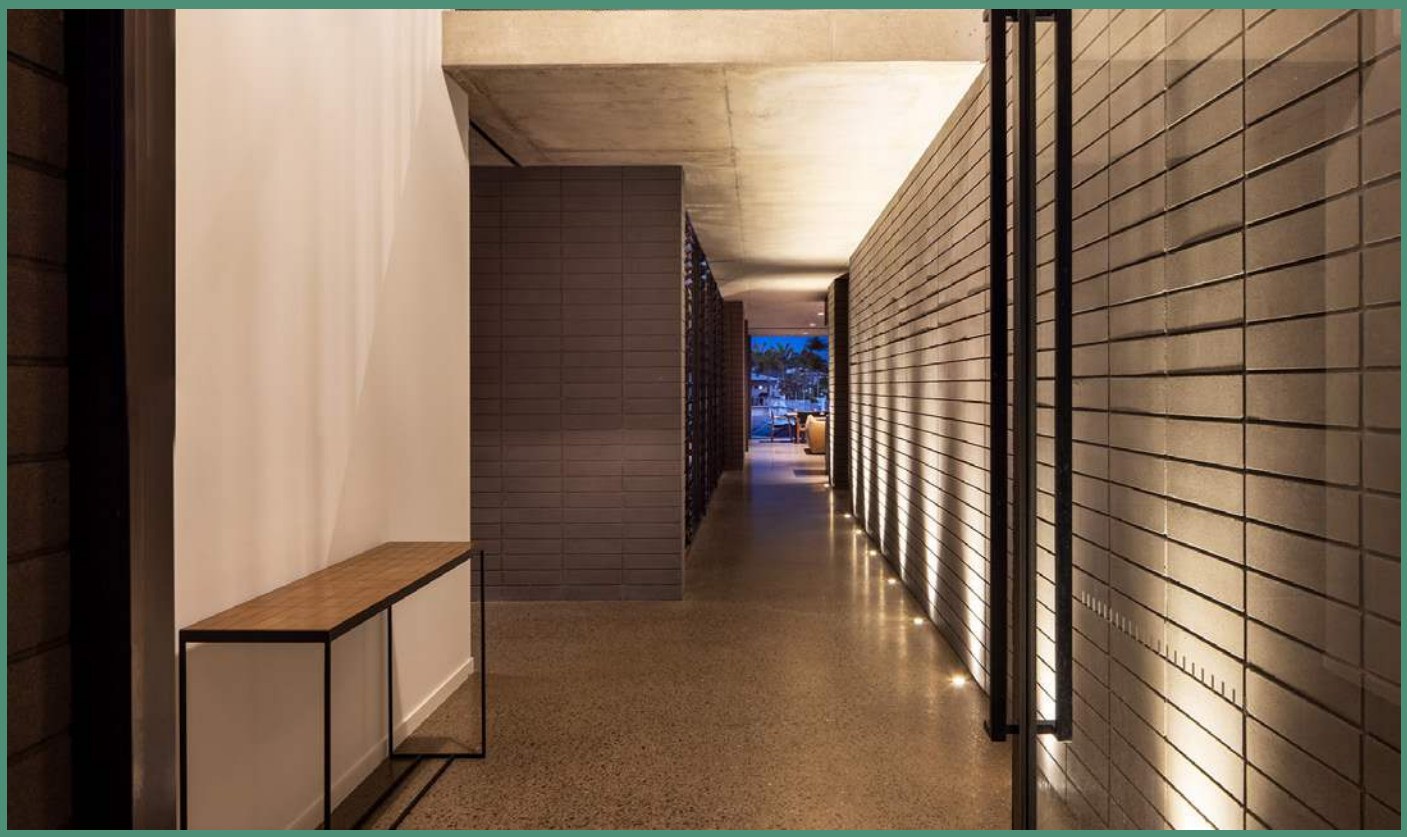
- Overlay 1 side
- 2400 x 1200 only
- Available in both 5mm & 9mm

Tried and tested

ArmourForm has been used on significant projects across Australia for more than 30 years, including Sydney's Anzac Bridge, Sydney Harbour Tunnels, Lang Park Stadium, Barangaroo Towers, Crown Towers, Sydney Olympic Stadium, Chevron Towers Elizabeth Quay and Queens Wharf Brisbane. ArmourForm has been exported to New Zealand, England, the Middle East and South-East Asia, and used in many internationally renowned construction sites.

Fully accredited

All Big River formwork products are certified by the Plywood Association of Australia (PAA). Products carrying the PAA stamp are manufactured and product certified to relevant Australian and New Zealand Standards under the PAA's third party audited quality control program.



References

1 National Precast Concrete Association Australia. “Finishes - Classes, quality and colour of off-form grey precast (AS 3610).” NPCAA. https://www.nationalprecast.com.au/wp-content/uploads/2015/10/classes-quality-and-colour-off-form-precast.pdf (accessed 14 May 2023).

2 National Precast Concrete Association Australia. “Specification of Surface Finishes under AS 3610.” NPCAA. https://www.nationalprecast.com.au/wp-content/uploads/2015/10/Precaster-42-small.pdf (accessed 14 May 2023).

3 National Precast Concrete Association Australia. “Specification of Surface Finishes under AS 3610.” NPCAA. https://www.sria.com.au/expertise/finish3.pdf (accessed 14 May 2023).

4 Ibid.

5 Above n 1.

6 Ibid.

7 Ibid.

8 Cement Concrete & Aggregates Australia. “Guide to Off-form Concrete Finishes.” CCAA. https://www.ccaa.com.au (accessed 14 May 2023).

9 Lyngcoln, KJ. Plywood in Concrete Formwork (Plywood Association of Australia, 1988).

10 Ibid.

11 Concrete New Zealand Inc. “Off-the-form concrete surface finishes.” Build Magazine. https://www.buildmagazine.org.nz/assets/PDF/Build-165-24-Build-Right-Off-The-Form-Concrete-Surface-Finishes.pdf (accessed 14 May 2023).

12 Above n 9.

13 Ibid.

14 Engineered Wood Products Association of Australasia. ”Technical Note: Formwork Plywood for Class 2 and Class 3 Surface Finishes to AS 3610.” EWPAA. https://ewp.asn.au (accessed 14 May 2023).

15 Ibid.

16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.