



Formwork for concrete

Part 1: Specifications



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 - Australian Industry Group
 - Australian Steel Institute
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 - Concrete Masonry Association of Australia
 - Consult Australia
 - Engineered Wood Products Association of Australasia
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 - Master Builders Australia
 - National Precast Concrete Association Australia
 - SafeWork NSW
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-

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Australian Standard®

Formwork for concrete

Part 1: Specifications

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PREFACE

This Standard was prepared by the Standards Australia Committee BD-043, Formwork, to supersede, in part, AS 3610.1—2010, *Formwork for concrete, Part 1: Documentation and surface finish*.

The objective of this Standard is to set out requirements for the specification and documentation of architectural, structural and construction information necessary for formwork design and construction. This Standard also sets out requirements for documentation of formwork designs and information on proprietary formwork. It also sets out the requirements for the assessment and evaluation of completed surface quality and repairs.

The full review of AS 3610 series is in progress and therefore it was considered appropriate to issue the Standard in two Parts:

- (a) AS 3610.1, *Formwork for concrete, Part 1: Formwork specification* (this Standard), focuses on surface finish and covers various types of documentation applicable to formwork. This Part was revised and published in 2010. This latest revision includes relevant commentary clauses from AS 3610 Supplement 2—1996 *Formwork for concrete—Commentary*
- (b) AS 3610.2, will cover aspects of formwork and falsework design, construction and testing, including Section 4 of AS 3610.1—2010.

NOTE: At the time of publication, this Standard is still under review.

AS 3610.2, AS 3610—1995 and AS 3610.1 will coexist. Sections 2, 3 and 5 in this Standard (AS 3610.1) supersede Sections 2 and 3, as well as Clauses 4.7 and 5.6 of AS 3610—1995.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

This Standard incorporates commentary on some of the Clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a box. The commentary is for information and guidance only and does not form part of this Standard.

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STANDARDS AUSTRALIA

Australian Standard
Formwork for concrete**Part 1: Specifications**

SECTION 1 GENERAL

1.1 SCOPE

This Standard sets out—

- (a) the requirements for the documentation of architectural, structural and construction information necessary for formwork design and construction;
- (b) architectural requirements and procedures covering the specification of the quality, tolerance, colour, and evaluation of off-form or as-repaired in situ or precast concrete surfaces; and
- (c) structural requirements that—
 - (i) are critical to the stability, strength and serviceability of the permanent structure during construction and once completed; and
 - (ii) affect the formwork design and construction.

This Standard does not apply to unformed surfaces. The requirements in this Standard apply to plain concrete surfaces left off-form or prior to application of surface treatment or coating. This Standard does not cover the specification of textured finishes, surface treatment, coatings or paint.

1.2 APPLICATION

Project, construction, formwork and proprietary documentation shall conform with Section 2.

The physical quality, colour control, evaluation and repairs of the concrete surface, as well as test panels, shall conform with Section 3.

Structural requirements for limitations on construction loads, multistorey shoring, minimum stripping times and procedures, construction sequence and other specific information are set out in Section 4.

Appendix A provides formwork importance levels in different situations.

Appendix B provides blowhole photographs which are intended for use in the evaluation of completed work.

Appendix C provides guidance on the documentation of formwork stripping times.

Appendix D provides general commentary on Section 3.

Appendix E provides an informative glossary of terms.

1.3 NORMATIVE REFERENCES

The following are normative documents referenced in this Standard.

AS	
3600	Concrete structures
3610	Formwork for concrete

1.4 ALTERNATIVE CONCEPTS AND MATERIALS

Alternative concepts, materials, designs, methods of assembly and procedures, which are not mentioned in this Standard, may be used provided it can be demonstrated that the resulting formwork conforms to the requirements specified in this Standard.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

NOTE: For guidance and informative purposes, a glossary of terms is listed in Appendix E.

1.5.1 Administrative definitions

1.5.1.1 *Acceptable*

Conforms with the criteria set out in this Standard.

1.5.1.2 *Back form*

A form for a concrete surface that is totally concealed in the finished structure.

1.5.1.3 *Bearer*

Part of soffit form framing. A primary member supported on formwork supports or hangers and carrying joists.

1.5.1.4 *Cantilever forms*

Forms that are solely supported by anchors embedded in the exposed face of previously placed concrete.

1.5.1.5 *Competent person*

A person who has acquired through training, qualification or experience or a combination of these, the knowledge and skills that enable the person to safely and effectively perform the task required.

1.5.1.6 *Construction documentation*

Documents that set out information on the planned construction method for the permanent structure, which are required for the formwork design and construction.

1.5.1.7 *May*

Indicates the existence of an option.

1.5.1.8 *Project documentation*

Drawings, specifications and associated documents that set out the information required for the construction of the permanent structure.

1.5.1.9 *Proprietary documentation*

Brochures, catalogues, drawings, specifications and associated documents that detail proprietary formwork.

1.5.1.10 *Shall*

Indicates that a statement is mandatory.

1.5.1.11 Should

Indicates a recommendation.

1.5.1.12 Soldier

Part of a side form. A vertical primary member supported by form ties or form bracing.

1.5.1.13 Waler

Part of a side form, either—

- (a) a horizontal primary member supported by form ties or form bracing; or
- (b) a horizontal secondary member.

1.5.2 Technical definitions**1.5.2.1 Action**

Set of concentrated or distributed forces acting on a structure (direct action), or deformation imposed on a structure or constrained within it (indirect action).

NOTE: The term 'load' is also often used to describe direct actions.

1.5.2.2 Backpropping

A process by which adjustable supports are placed to give support to the cast in situ concrete during the removal of the soffit formwork, which may also remain in position to act as multistorey shoring (see Figure 1.5.2.2).

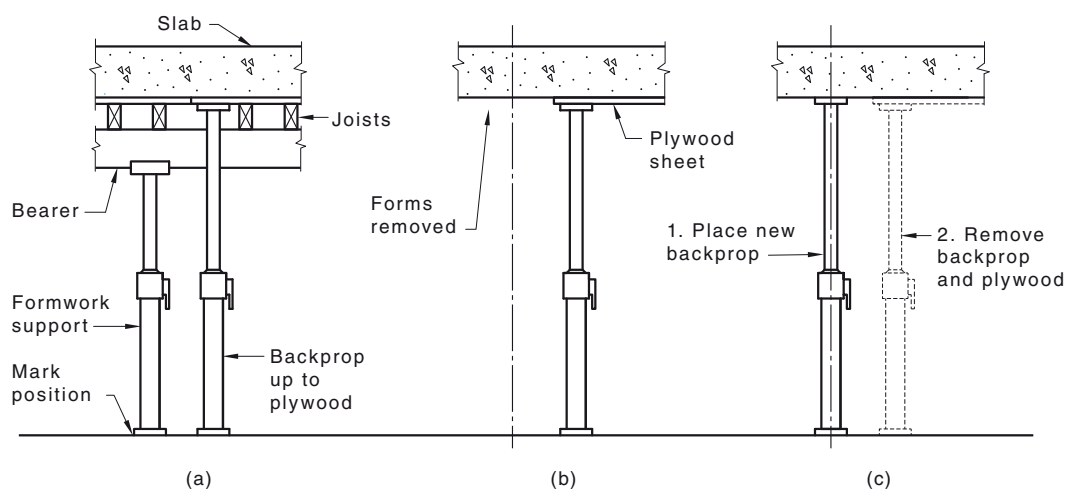


FIGURE 1.5.2.2 EXAMPLE OF BACKPROPPING

1.5.2.3 Blowhole

Shallow pocket or void in the formed surface of the concrete caused by a bubble of fluid or air trapped against the form face.

1.5.2.4 Bracing

Members that normally do not support gravity loads but are required to provide lateral stability or restraint to other members or to transfer horizontal actions to anchorage or reaction points.

1.5.2.5 Camber

The intentional curvature of formwork prior to concrete placement to compensate for the deflection of the formwork or element under load.

1.5.2.6 Cast in situ concrete

Concrete that is placed, as plastic concrete, in its final location.

1.5.2.7 Class of surface finish

Standard of the untreated concrete surface of the formed concrete.

NOTE: Also known as 'class'.

1.5.2.8 Colour control

The limitation of tonal range of cast in situ concrete and precast concrete.

1.5.2.9 Component

A structural member.

1.5.2.10 Construction joint

A joint, including a joint between precast segments, that is located for the convenience of construction.

1.5.2.11 Deflection

Flexural movement of a structural member or assembly in response to the forces acting on it.

1.5.2.12 Design service load

The permanent and imposed loads for which the design of the permanent structure is based.

1.5.2.13 Deviation

The divergence from the specified position.

1.5.2.14 Element

That concrete portion of the permanent structure defined by the formed concrete faces, mandatory joints, construction joints and the completed concrete surfaces, which is cast in one continuous operation.

1.5.2.15 Falsework

A part of the formwork that supports the form and transfers all the loads to a stable surface(s) prior to, during and following concrete placement.

1.5.2.16 Flatness

The variations in the formed surface resulting from movement of the formwork.

1.5.2.17 Footing

A part of the falsework in direct contact with, and transmitting load to, the supporting foundation.

NOTE: A footing may be purpose built, such as a simple sole plate, concrete footing or pile. Alternatively, an element may be used as a footing.

1.5.2.18 Form

A part of the formwork that contains and moulds the cast in situ concrete to the required dimensions.

NOTE: This includes the form face and framing.

1.5.2.19 Form face

That part of the form which comes in direct contact with the plastic concrete.

1.5.2.20 *Form face deflection*

The undulation of the concrete surface resulting from the deflection of the form face between members of the framing.

1.5.2.21 *Form liner*

Non-structural material placed on, or part of, the form face to achieve a desired surface finish.

NOTE: Also known as 'form lining'.

1.5.2.22 *Form tie*

A device that penetrates the formwork, extends through the void for the cast in situ concrete and restrains the formwork movement due to concrete pressure.

NOTE: Also known as 'wall tie' or 'tie rod'.

1.5.2.23 *Formwork*

Temporary works erected to mould and support cast in situ concrete.

NOTE: This consists of a form and, where appropriate, falsework, form bracing and form ties.

1.5.2.24 *Foundation*

Soil, subsoil or rock, whether built up or natural, upon which the permanent structure or the formwork is supported.

1.5.2.25 *Frame*

A falsework component assembled from three or more pieces into a planar unit.

1.5.2.26 *Framing*

Part of the form consisting of primary members and secondary members that support the form face.

1.5.2.27 *Grout loss*

The loss of fine material, cement and fine aggregate, from plastic concrete due to openings in the form face.

NOTE: Also known as 'mortar loss'.

1.5.2.28 *Honeycombing*

Voids in concrete caused by the mortar not filling the spaces between the coarse aggregate particles.

1.5.2.29 *In situ concrete*

Concrete which is placed in its final location in the permanent structure.

1.5.2.30 *Limit state*

A state beyond which the structure no longer satisfies the design performance requirements.

NOTE: Limit state separate desired state (no failure) from undesired state (failure).

1.5.2.31 *Mandatory joint*

A joint specified in the project documentation.

1.5.2.32 *Permanent form*

A form that it is not stripped.

NOTE: Examples of permanent forms include horizontal precast concrete elements and profiled steel sheeting.

1.5.2.33 *Permanent structure*

The subject of the project documentation.

1.5.2.34 Plastic concrete

Concrete that has not yet achieved an initial set.

1.5.2.35 Precast concrete

A concrete element produced in a location other than its final location in the permanent structure.

NOTE: Also known as a 'prefabricated concrete element'.

1.5.2.36 Primary members

Framing members that directly support the secondary members, e.g. soldiers, bearers, beams.

1.5.2.37 Prop

A structural member designed to be loaded in compression.

1.5.2.38 Proprietary formwork

Multiple-use or mass-produced formwork systems and/or components.

1.5.2.39 Release agent

A substance applied to the form face or form liner surface to prevent bonding of the fresh concrete to the form face or form liner and minimize blowholes.

1.5.2.40 Reshoring

The complete stripping and removal, or relaxation, of the soffit forms and formwork supports so that the concrete structure supports itself followed by the immediate installation or resetting of adjustable supports (reshores), which may also remain in position to act as multistorey shoring.

NOTE: See Figure 1.5.2.40.

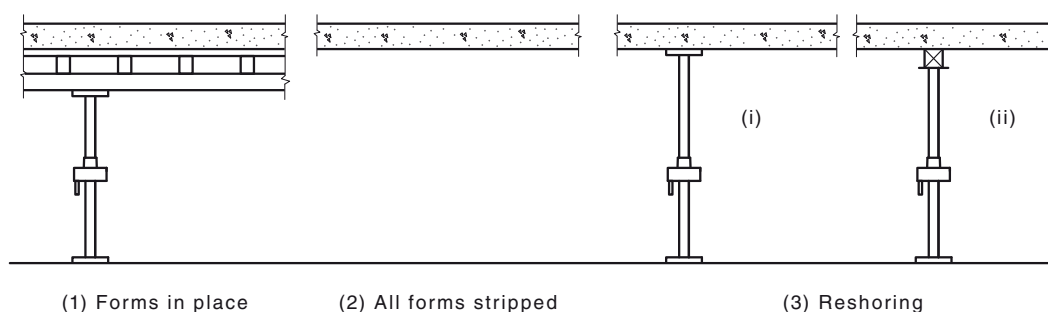


FIGURE 1.5.2.40 EXAMPLE OF RESHORING

1.5.2.41 Secondary members

Framing members that directly support the form face, e.g. joists and walers.

1.5.2.42 Serviceability limit state

A limit state of acceptable in-service condition.

1.5.2.43 Single-use formwork

Formwork components or systems that are used one.

1.5.2.44 Soffit formwork

Formwork for the undersides of slabs, beams, and other similar structural members.

1.5.2.45 *Stacked materials*

Construction materials, such as formwork, bricks and reinforcement, that temporarily load either the formwork or the previously placed concrete.

1.5.2.46 *Strain movement*

Any forced change in the position or dimension of the permanent structure.

1.5.2.47 *Strength limit state*

A limit state of collapse or loss of structural integrity.

1.5.2.48 *Stripping*

The removal of formwork from the surface of the hardened concrete.

NOTE: Also known as 'striking'.

1.5.2.49 *Structural reinforcement*

Reinforcement, including reinforcing steel and prestressed tendons, provided for crack control or to resist forces caused by design service loads and thermal and shrinkage movements.

1.5.2.50 *Supports*

The falsework members that transmit all or part of the loads to a lower level.

NOTE: This term includes multistorey supports for undisturbed shoring reshoring.

1.5.2.51 *Surface finish*

The texture and smoothness of a surface of hardened concrete where the plastic concrete has been shaped by a form face.

1.5.2.52 *Surface treatment*

The removal of a specified depth of the concrete of the permanent surface by a nominated chemical or mechanical means such as acid etching, sand blasting or jack picking.

NOTE: This does not include applied finishes such as coatings or paint.

1.5.2.53 *Surface undulation*

The undulation of the concrete surface resulting from the aggregation of form face deflection, framing deflection and the aggregation of errors in setting, movement of support points and material dimensional tolerances.

1.5.2.54 *Test panel*

A concrete element constructed, prior to the commencement of construction of the permanent structure, as an example of materials and quality of work.

1.5.2.55 *Tolerance*

Permitted variation in dimension.

1.5.2.56 *Tonal range*

The graded set of grey tones provided in this Standard, or specified in the project documentation when special-class concrete is used, for evaluation of the colour of the concrete surface.

1.5.2.57 *Undisturbed shoring*

Undisturbed supports or backpropping that remain in position and prevent the concrete structure from supporting itself.

1.5.2.58 *Undisturbed support*

A support that, as part of a soffit formwork, remains undisturbed until that part of in situ concrete structure is strong enough to support itself even though the soffit form may have been removed earlier.

NOTES:

- 1 See Figure 1.5.2.58.
- 2 The support may also remain in position to act as multistorey shoring.

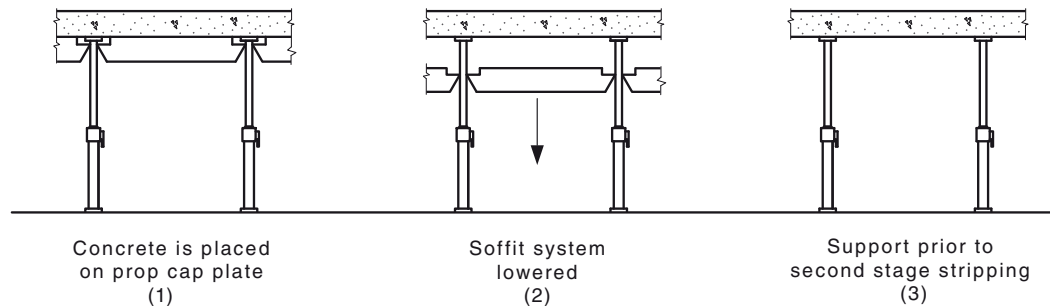


FIGURE 1.5.2.58 EXAMPLE OF UNDISTURBED SUPPORT

1.5.2.59 *Working load limit (WLL)*

The maximum unfactored load that may be applied to an item, component or system calculated in accordance with AS 3610.

NOTE: This is an unfactored load or capacity and not a strength limit states load or capacity.

1.5.2.60 *Working platform*

A platform used to provide a working area to support persons and their materials and equipment.

1.5.2.61 *Wrecking strip*

A small strip of formwork that is destroyed to facilitate stripping.

SECTION 2 DOCUMENTATION

2.1 SCOPE OF SECTION

The project and construction documentation includes all the information about the permanent structure and its construction necessary to design, construct and strip the formwork, as well as information necessary to evaluate and repair the finished concrete surface.

The formwork and proprietary documentation includes additional information necessary to design, construct and/or strip the formwork.

The information to be specified in the—

- (a) project documentation is given in Clause 2.2;
- (b) construction documentation is set out in Clause 2.3;
- (c) formwork documentation is set out in Clause 2.4; and
- (d) proprietary documentation is set out in Clause 2.5.

C2.1 In general, documentation could comprise drawings, written specifications, photographs, brochures, technical data and calculations, as well as written or even verbal instructions. Documentation may be the compilation of information from different sources.

2.2 PROJECT DOCUMENTATION

2.2.1 General

The project documentation shall meet the requirements of Sections 3 and 4, as well as include specific requirements for the project that are achievable including—

- (a) details of the concrete elements and any conditions relating to production;
- (b) architectural requirements for the concrete surface quality, dimensional tolerance, colour control and test panels; and
- (c) structural requirements matters that—
 - (i) are critical to the stability, strength and serviceability of the permanent structure during construction and once completed; and
 - (ii) affect the formwork design and construction.

NOTES:

- 1 For particular projects, the requirements of Clause 2.2 may be insufficient and many other aspects may require attention.
- 2 Preparing the project documentation often requires co-operative effort involving all participants, e.g. achieving a high quality of surface finish or specifying multistorey shoring.

The activities of the formwork construction can have a far-reaching effect on the safety and serviceability of the permanent structures, therefore, attention is drawn to the need to review the formwork documentation to ensure it meets the requirements of the project documentation.

C2.2.1 The purpose of the project documentation is to ensure that all necessary requirements are fully and accurately communicated to those concerned with the design, construction and stripping of the formwork.

2.2.2 General information

The project documentation shall include the following information:

- (a) Plans, elevations and sections showing details and dimensions of the elements to be formed.
- (b) Details of any inserts, waterstops, special purpose form ties, specially formed shapes, or penetrations to be constructed, that are critical to the serviceability of the permanent structure.
- (c) Information on specified concrete ingredients or admixtures that may affect the concrete finish by, but not limited to—
 - (i) retarding or accelerating the setting time of the concrete including artificial heating or cooling;
 - (ii) causing excessive blow holes on the surface of the concrete; and
 - (iii) increasing colour or tonal variability.
- (d) Structural details consistent with the architectural requirements.

2.2.3 Architectural information

The project documentation shall include the following information, where applicable:

- (a) Identification of class of surface finish:
 - (i) The class of surface finish and if colour control is applicable for the formed face of each element in the notation format as required under Clause 3.2.2 and as applicable under Clause 3.2.3.
 - (ii) The details set out in Table 2.2.3 relating to surface finish, colour control, critical elements, tolerances and repairs, where relevant, for all surfaces of the permanent structure.
 - (iii) Where an 'X' suffix is used as permitted in Clause 3.2, all relevant information relating to—
 - (A) any additional feature not covered by this Standard; or
 - (B) the relaxation of the requirements of this Standard (see Table 3.3.3.1 Row 3, Table 3.3.5.1, Clause 3.3.3.2(b) and Clause 3.5.2).
- (b) Physical quality:
 - (i) Critical face of elements (see Clause 3.3.2).
 - (ii) Concrete surfaces where light shines across the surface at a flat angle, particularly in the case of smooth glossy finishes (see Clause 3.3.4.1).
 - (iii) If the requirements for Class 2 are relaxed to permit the use of modular panel frames that leave imprints in the concrete surface (see Table 3.3.3.1 Row 3).
 - (iv) Where tolerances in AS 3600 govern because they are more stringent than those specified in this Standard (see Clause 3.3.5).
 - (v) Any special measuring points and small areas where more stringent tolerance values than those given in Table 3.3.5.1 apply (see Clause 3.3.5.1).
 - (vi) Permitted tolerances and methods of evaluation for the surface finish of curved. Irregular or unusual surfaces or shaped elements equivalent to the requirements specified in Clause 3.3 for straight surfaces and regular shaped elements.
 - (vii) Precast concrete panel twist tolerance reference line or surface, if applicable [see Clause 3.3.6.2(c)(iv)].

- (viii) Architectural details to be cast into the concrete (see Table 2.2.3).
- (c) Colour control:
 - (i) Concrete colour.
 - (ii) Details of special-class concrete required under Clause 3.4.2.
 - (iii) If the specified concrete colour is unsuited to the tonal range shown in Figure 3.4.4, a suitable means of representing an equivalent tonal range and gradation shall be specified (see Clauses 3.4.3 and 3.4.4).
 - (iv) Details consistent with the achievement of the specified colour and acceptable tonal range, including stripping time.
 - (v) The concrete age for checking colour control (see Clause 3.4.6).
- (d) Repairs:
 - (i) Any restriction on repairs to Class 1 concrete surfaces (see Clause 3.6.1).
 - (ii) Limitations on the extent of repairs permitted (see Clause 3.6.1).
 - (iii) Acceptable method of repair for unacceptable blow holes, honeycombing and grout loss (see Table 3.3.3.1 and Clause 3.6.2).
 - (iv) Whether or not form ties holes are to be repaired and acceptable method of repair (see Table 3.3.3.1 Item 2 and Clause 3.6.2).
- (e) Test panels:
 - (i) The details set out in Table 2.2.3 relating to test panels.
 - (ii) Construction details of test panels that contain accurate representations of the completed work (see Clause 3.7.3).
 - (iii) Procedures for evaluating the completed work using test panels, where permitted (see Clause 3.7.2).

TABLE 2.2.3
PROJECT DOCUMENTATION REQUIREMENTS
FOR CLASS OF SURFACE FINISH

Details to be provided for	Class 1	Class 2	Class 3	Class 4	Class 5	Reference
1 Test panels, for—						Clause 3.7
(a) untreated surfaces	TBS	TBS	OPT	N/A	N/A	Clause 3.3.8
(b) colour controlled surfaces	TBS	TBS	TBS	N/A	N/A	Clause 3.4.7
(c) repaired surfaces	SIA	TBS	OPT	N/A	N/A	Clause 3.6.4
2 Form face sheet, form face fixing and form tie patterns as well as details	SIA	SIA	OPT	N/A	N/A	N/A
3 Chamfers, drip-grooves and other inlays	SIA	SIA	SIA	SIA	N/A	N/A
4 Form liner details, pattern and accuracy	N/A	SIA	SIA	N/A	N/A	N/A
5 Surface pattern details and accuracy	SIA	SIA	SIA	N/A	N/A	N/A
6 Surface treatment pattern of part of surface	SIA	SIA	SIA	N/A	N/A	Clause 3.5
7 Surface treatment of whole of surface	N/A	SIA	SIA	N/A	N/A	Clause 3.5
8 Form face span and direction of span	OPT	OPT	N/A	N/A	N/A	Table 3.3.3.1
9 Critical faces of elements	SIA	SIA	SIA	SIA	N/A	Clause 3.3.2
10 Face steps	OPT	OPT	OPT	N/A	N/A	Table 3.3.5.1
11 Plumb of elements height >8 m	SIA	SIA	SIA	SIA	SIA	N/A
12 Repairs (see Note)	OPT	ACC	ACC	ACC	ACC	Clause 3.6
13 Colour control	SIA	SIA	SIA	NA	NA	Clause 3.4

LEGEND:

TBS To be specified—these are mandatory project documentation requirements for all work where the particular class of surface finish has been specified

N/A Not applicable—these are matters that are not applicable to the particular class of surface finish

OPT Optional—these are matters that may be included in the project documentation

SIA Specify if applicable—these are mandatory where the particular feature is included in the project documentation

ACC Acceptable—repairs to the particular class of surface finish is acceptable

NOTE: Repairs to a class of surface finish marked ACC shall not be excluded in the project documentation.

C2.2.3 Class 1 is extremely difficult, time consuming and costly to achieve. Class 1 should not be specified for any situations other than very special features of buildings of a monumental nature. For all other situations requiring the highest quality architectural off-form concrete surface finish, Class 2 should be specified. Where the concrete surface finish is not subject to close scrutiny and viewed as a whole, Class 3 should be specified. See Clause 3.2.3 for further guidance.

2.2.4 Structural information

The project documentation shall include the following information, where applicable:

- (a) Construction loads (see Clause 4.2):
 - (i) The design service loads for the structure, including any reduction factors incorporated.
 - (ii) Permission to use part of the permanent structure or existing structures to support the formwork as a point of resistance or restraint for the formwork and any limitations that may apply to the magnitude and locations of vertical or horizontal construction loads permitted to be applied in relation to the minimum concrete strength and stiffness to be achieved prior to the application of the loads.
 - (iii) The maximum permitted construction loads that can be applied directly to the structure and any limitations on the location of these loads, e.g. stacked materials.
 - (iv) Information on the magnitude, location and any redistribution of, or change to, the construction loads the formwork shall support; any movements that may occur; and any special formwork provisions necessary as a result of the effects of post-tensioning or prestressing procedures.
- (b) Multistorey shoring (see Clause 4.3).

The method and details of multistorey shoring, the anticipated load distribution between the floors and the assumptions upon which the multistorey shoring design is based.
- (c) Minimum stripping times and procedures (see Clause 4.4).
- (d) Construction sequence (see Clause 4.5):
 - (i) Sequence of construction of concrete elements, if this is critical.
 - (ii) Location and details of any mandatory joints or delayed pour strips.
 - (iii) Details and any special procedures for locating construction joints.
- (e) Specific information (see Clause 4.6):
 - (i) Requirements for any composite construction (see Clause 4.6.2).
 - (ii) Information about any permanent form systems (see Clause 4.6.3).
 - (iii) Information necessary to take account of the effects of concrete shrinkage, creep and axial shortening (see Clause 4.6.4).
 - (iv) Any information about the foundation that is relevant to the support of the formwork or design of the footings for the falsework (see Clause 4.6.5).
 - (v) Guidelines and limitations on the locations of inserts and penetrations that otherwise may impair the safety and serviceability of the permanent structure.
 - (vi) Details of areas where congestion of reinforcement or cast-in items will require modifications to the formwork to ensure correct concrete placement and vibration, e.g. openings for immersion vibrators, provision for external vibration or use of self-consolidating concrete.

2.3 CONSTRUCTION DOCUMENTATION

2.3.1 General

The construction documentation shall conform with the project documentation and set out specific requirements of the planned construction that affect the formwork.

NOTES:

- 1 The purpose of the construction documentation is to ensure that all necessary requirements are fully and accurately communicated to those concerned with the design, construction and stripping of the formwork.
- 2 Attention is drawn to the need to review the formwork documentation to ensure it meets the requirements of the construction documentation.

2.3.2 Documentation

The construction documentation shall include the following, where applicable:

- (a) Details of any anticipated changes to the project documentation.
- (b) Construction method, sequence and schedule.
- (c) Details coordinating building services, assembly of reinforcement and cast-in items.
- (d) Location of construction joints required in addition to those specified in the project documentation.
- (e) Where colour control has been specified:
 - (i) Details and methods to ensure the consistency of raw materials, concrete placement, curing and avoiding visible layers of concrete.
 - (ii) Details of the quality management and supervision procedures for assembly and erection of the formwork, application of release agent, placement of reinforcement, quality of concrete, casting and compacting concrete, stripping formwork, curing and protection of the concrete surface.
- (f) Relevant details of the plant and equipment to be used in the construction.
- (g) Details of the interface between the formwork and other construction equipment and activities.
- (h) The location and weight of all materials to be stored on or supported directly or indirectly by the formwork; including formwork and other construction materials and equipment, as well as building materials, plant and equipment.
- (i) Information on construction activities and constraints that affect the formwork.
- (j) Information on construction loads the formwork supports and any redistribution of loads.
- (k) Details of access, egress and edge protection that affect the formwork.
- (l) Documentation for equipment, material or components to be incorporated in the formwork.
- (m) Plans for transporting, handling, moving and re-use of the formwork.
- (n) Method and rate of concrete delivery, placement sequence, discharge heights and rate of rise.
- (o) Concrete temperature at time of placement, if greater than 30°C or less than 5°C.

2.4 FORMWORK DOCUMENTATION**2.4.1 General**

The formwork documentation shall set out the requirements of the formwork design. The formwork documentation shall contain a statement that the formwork design and documentation conforms with AS 3610.

To permit the formwork to be verified, constructed and inspected prior to use, providing formwork documentation is mandatory for formwork in Importance level II or Importance level III (see Appendix A).

2.4.2 Documentation

The formwork documentation shall include the following, where applicable:

- (a) Plans, elevations and sections sufficient to depict the general arrangement of the formwork and multistorey shoring, and to identify and locate all members, including bracing.
- (b) Details sufficient to fully describe important or unusual features of the design, including all items specified in the project documentation as required in Table 2.2.3.
- (c) Method statements covering the erection and stripping of formwork and multistorey shoring.
- (d) Where colour control is specified, procedures and details necessary to satisfy the requirements of project documentation, including: form face materials, sealing of form face sheet and all joints.
- (e) Reference to proprietary documentation (see Clause 2.5).
- (f) Where non-destructive test methods are to be used to evaluate the structural capacity of formwork, the appropriate test load and details of the test procedure.
- (g) Acceptance criteria for single-use formwork.
- (h) The weight of stacked materials taken into account in the formwork design and details of the areas of the formwork designed to carry stacked materials and any limitations thereto.
- (i) Requirements of the project and construction documentation that relate to formwork, as specified in Clauses 2.2 and 2.3.
- (j) Method of field adjustment of the formwork.
- (k) Where required, location of inserts, weepholes, vibrator holes, clean-out holes, and inspection openings.
- (l) Sequence and method of concrete placement and the minimum elapsed time between adjacent placements.
- (m) Location and details of construction joints.
- (n) Stripping procedures, including details and placement of wrecking strips and other details relating to stripping.
- (o) Details of deviation indicators, if required.
- (p) The design assumptions in accordance with AS 3610, as follows:
 - (i) Permanent actions.
 - (ii) Imposed actions.
 - (iii) Accidental actions.
 - (iv) Concrete pressure and the parameters used to determine its magnitude including—
 - (A) wet density of concrete;
 - (B) rate at which concrete rises vertically up the formwork;
 - (C) type of cement;
 - (D) percent content of fly ash and slag;
 - (E) concrete temperature at placement;
 - (F) form height;

- (G) concrete discharge height; and
- (H) vertical pour height.
- (v) Whether the design allows for any admixture that has a retarding effect to be used in the concrete.
- (vi) Environmental actions and site conditions.
- (vii) Other actions.
- (viii) Permitted imperfections.
- (q) The footing design assumptions, such as foundation material description, minimum bearing value, limitations on settlement during Stages 1, 2 and 3. Reference to information sources such as geotechnical reports shall also be included.
- (r) Preparation of the foundation, such as filling, compaction, drainage and precautions against flooding.
- (s) The footing details such as type, size and relevant levels.
- (t) Details of materials and components, including the type, quality, grade and, where applicable, the relevant Australian Standard.
- (u) Application and type of release agent.
- (v) Details of any specialist surface finish requirements such as board, rope finish, etc.

C2.4.2 *Until its removal, the formwork carries the construction load and also provides safe working areas and access ways for construction personnel. It is therefore of significant importance that the engineering design be communicated by adequate documentation.*

The extent of the documentation will largely depend on the complexity of the structure, and on the design and details of the formwork. In preparing the formwork documentation, it is expected that the supervision, fabrication, erection, use and removal of the formwork will be carried out by competent persons (see Clause 1.5.1.2).

Regardless of whether the formwork design is carried out by one or more persons, it is essential that the formwork documentation adequately covers the design. Where separate documentation is provided (e.g. documentation for single-use items, proprietary items, footings) it should be brought together to make up the formwork documentation in a contiguous and coordinated manner.

2.5 PROPRIETARY DOCUMENTATION

2.5.1 General

The proprietary documentation shall set out the information required for the correct use of proprietary formwork.

2.5.2 Documentation

Proprietary documentation shall include the following information:

- (a) Drawing or pictorial representation that clearly identifies the formwork to which it refers.
- (b) Adequate information to fully describe its intended use and any limitations thereto.
- (c) Instructions for use and, where applicable, maintenance of the formwork.
- (d) The strength and serviceability limit state capacities in accordance with AS 3610 and relevant materials Standards.

- (e) The working load limit as calculated in accordance with AS 3610.
- (f) A statement that the formwork depicted and the proprietary documentation is in accordance with AS 3610.
- (g) Detailed information including, where appropriate—
 - (i) part number;
 - (ii) dimensions;
 - (iii) structural properties, including: section and material properties, weight, axial elastic stiffness and moment-rotation characteristics;
 - (iv) geometric imperfections which affect its use or structural capacity and behaviour, including: eccentricities, out-of-straightness and any permanent camber built into the item;
 - (v) details of any special attachments (e.g. access brackets, hand rail posts, plumbing feet); and
 - (vi) locations for tie bolts or support points.

NOTE: Proprietary documentation should include adequate information to permit structural analysis of formwork assemblies to determine or verify their structural capacity and behaviour.

C2.5 *Clause 2.5 lists the minimum information to be given on an information brochure so that it can be a valid and acceptable part of the formwork documentation.*

SECTION 3 ARCHITECTURAL REQUIREMENTS

3.1 SCOPE OF SECTION

3.1.1 General

This Section specifies the requirements for—

- (a) identifying and selecting the appropriate class of surface finish (see Clause 3.2);
- (b) the acceptable physical quality of cast in situ and precast concrete (see Clause 3.3);
- (c) colour control of untreated surfaces (see Clause 3.4);
- (d) matters related to surfaces prior to treatment (see Clause 3.5);
- (e) repairs (see Clause 3.6); and
- (f) test panels (see Clause 3.7).

3.1.2 Application

The following requirements apply:

- (a) Plain concrete surfaces left off-form or prior to application of surface treatment or coating.
- (b) Both formed precast and cast in situ concrete surfaces.

This Section does not apply to—

- (i) unformed concrete surfaces, textured or treated surfaces (for example, where the surface is treated with a secondary finishing operation using chemical or mechanical means); and
- (ii) the surface of permanent forms made from materials other than concrete, e.g. sheet metal permanent forms.

The quality of the surface finish and colour control of precast concrete permanent forms shall be evaluated after pre-casting.

C3.1.2 The intention of Clause 3.1.2 is to specifically exclude the application of Section 3 to permanent form surfaces of materials other than concrete, e.g. metal, GRC, etc. In addition, the Clause clarifies that Section 3 applies to the physical quality and colour of the concrete surface of precast concrete permanent forms after they have been cast (i.e. as result of the precast element formwork) and not after installation on site.

3.2 CLASSES OF SURFACE FINISH AND COLOUR CONTROL

3.2.1 General

The class of surface finish and where colour control is incorporated shall be—

- (a) identified in accordance with Clause 3.2.2; and
- (b) selected in accordance with Clause 3.2.3.

3.2.2 Notation

There are five classes of surface finish, each class being identified by the appropriate numeral from 1 to 5.

Where colour control is incorporated this shall be denoted by the suffix 'C' following the surface finish class numeral (see Notes 1 and 2).

The suffix 'X' shall be added to identify where the project documentation [see Clause 2.2.3(a)(iii)], specifies:

- (a) Any additional feature (an extra feature not covered in this Standard, see Note 3).
- (b) Less stringent requirements than specified in this Standard (see Note 3).
- (c) Concrete faces with small areas where more stringent tolerance values than those given in Table 3.3.5.1 apply (see Note 4).

NOTES:

- 1 The requirements set out in Clause 3.4 do not apply without the suffix 'C' (see Notes 2 and 3).
- 2 Attention is drawn to Clause 3.4.1, which prohibits colour control for Classes 4 and 5.
- 3 For example, 2C denotes Class 2 with colour control and 2X and 2CX are valid descriptors of surface specifications that are either not covered in this Standard or less stringent than specified in this Standard (see Clause 3.2.1).
- 4 Attention is drawn to Clause 3.3.5.1, which limits the extent to which values that are more stringent than those assigned to the selected class can be specified in the project documentation as required by Clause 2.2.3(b)(v).

C3.2.2 *In recognition of the fact that no Standard can ever cover all the possibilities that are available in concrete finishes, and that many project designers may want to vary some of the provisions of the Clauses, a means of indicating an extra feature not covered by this Standard or a less stringent requirement is given by using the 'X' suffix to the surface designation, e.g. 1X, 2X, 3X. Additionally, using the 'C' prefix indicates that colour control is required in addition to the specified finish, e.g. 1CX, 2CX, 3CX. The use of this notation indicates to the formwork designer and the site staff the need to examine the project documents for information on extras and exceptions.*

This Standard does not place any limitations on the extras that the project designer may specify, but does place restrictions on the use of the 'X' notation for exceptions (variations) to this Standard. The 'X' suffix is applicable only to colour control and the mandatory requirements of the surface specification.

The 'X' suffix cannot be used to include any matters listed as 'Excluded' in Table 2.2.3. Neither can it be used to make the requirements of any class or its associated colour control more stringent. It is only used to denote changes to the requirements which are less stringent than those given in this Standard. For example, if the project designer requires a surface which is generally satisfied by Class 3 but wants some parts of this class made more stringent, then the project designer is required to specify this as 2X, with the specification giving details of those requirements of Class 2 that are reduced by the 'X' notation. The effect of this is to prevent the project designer from specifying anything which is more stringent than Class 1 or Class 1C. To specify this would be to ask for an impossibly high standard of workmanship.

The 'X' suffix can be useful in reducing the stringency of requirements for surfaces that are only viewed at a distance.

3.2.3 Applicability

The physical quality of the concrete surface shall be specified in the project documentation under a class numeral in accordance with Table 3.2.3.

If the class is not specified in the project documentation, the quality of the off-form surface is not required to be superior to Class 3, and selection of the appropriate class shall be by the visual characteristics and suitable uses set out in Table 3.2.3.

TABLE 3.2.3
APPLICABILITY OF SURFACE CLASSES

	Class 1 (see Note 2)	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 appearance Excellent quality of edge and joint details	Uniform quality and appearance over large areas Built to close tolerances Consistently good quality to edge and joint details	Good visual quality when viewed as a whole	Appearance not important Good general alignment	Alignment and appearance 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 and as a whole	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
Situations where not to be specified	For whole elevations or extended surface areas, 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. See Clause 3.4.4 for the tonal range that can be specified. Not appropriate for surfaces with applied finishes such as coatings or paint.			Excluded	
Surface treatment	Not applicable	May be specified (see Clause 3.5)			Not suitable

NOTES:

- 1 Achieving a high quality surface finish requires a timely co-operative effort involving all participants.
- 2 Class 1 is the highest standard with the most rigorous specification and is only recommended for use in very special features of structures of a monumental nature.
- 3 Different methods of forming elements and repair may affect the appearance of the surface finish. It is essential that test panels take this into account.
- 4 In regard to Class 2, the term 'viewed in detail' is applied at the viewing distances specified in Clause 3.3.3.2.
- 5 Facades equal to vertical faces only.
- 6 For tolerances see Table 3.3.5.1.

C3.2.3 *In keeping with the theme of this Standard, Table 3.2.3 is expressed in performance terms. Particular examples of the use of the several classes are as follows:*

Class 1 shall not be specified for concrete surfaces (as is common practice) other than prominent elements of monumental structures. This class represents the highest standard of workmanship. It is very expensive and extremely difficult to achieve. It should only be specified for surfaces that will be subject to close scrutiny. It should not be regarded as representing perfection as it, like the other classes, has permissible deviations for both colour and dimensions. The high standard of work required for its achievement precludes its use in all but elements contained in a single pour.

Ideally, the concrete should come from a single concrete delivery because of the near impossibility of repetitively meeting the stringent requirements of this class.

Foot or other traffic on the formwork usually leaves marks that are reflected in the poured face. For this reason Class 1 cannot be used on trafficable formed areas. Formed tops of elements usually have a problem of excessive blowholes and they are also excluded from Class 1.

Class 2 This class is also expensive. It would normally be used for general architectural work, e.g. the complete facades of buildings, public access areas, visible areas of bridge work and areas subject to close scrutiny. Its parameters are such that with stringent supervision and consistency of material supply, formwork, concrete placing, curing and protection, it can be repetitively achieved over large areas. This is the highest class for trafficable soffit work and is the highest class necessary for surfaces that are to be totally treated.

Class 3 Class 3 is for buildings and structures that are to be viewed as a whole, and where minor blemishes and defects do not tend to detract from the overall appearance. Carports, basement walls, industrial constructions, and portions of bridgework not readily visible, are suitable cases for its use. It is the lowest class for visible surfaces that do not have an applied finish or are untreated. It is also the lowest class for which colour control may be specified.

Class 4 This is for surfaces that are concealed from view, e.g. backs of retaining walls and insides of tanks and ducts, or that have an applied surface, e.g. render or tiling. The project designer should note the details of this class as its adoption may require some surface preparation before the application of the finish, e.g. the smoothing of face steps and filling of blowholes before the application of tanking membranes to retaining walls.

Class 5 This class is for totally concealed areas where the only requirements are structural adequacy, durability and serviceability, e.g. footings, foundation beams.

3.3 PHYSICAL QUALITY

3.3.1 General

Criteria for the acceptable physical quality and method of evaluation of each class of concrete surface finish and obligation for test panels is specified in this Section.

The tolerances given in this Section shall be read in accordance with those given in AS 3600. Tolerances in AS 3600 take precedence where more stringent than those specified in this Section. The concrete surfaces affected shall be identified in the project documentation [see Clause 2.2.3(b)(iv)].

For curved, irregular or unusual surfaces or shaped elements the requirements of Clause 3.3 may not be appropriate [see Clause 2.2.3(b)(iv)].

NOTE: Formwork tolerances for position and deviation from specified dimensions are not specified in this Standard. Taking account of the tolerances permitted in Tables 3.3.3.1, 3.3.4.1 and 3.3.5.1 may require adopting more stringent formwork tolerances for position and deviation from specified dimensions than specified in AS 3600 for as-cast concrete. Tolerances for position and deviation from specified dimensions that are not achievable (e.g. zero tolerance) should not be specified.

C3.3.1 *This Standard considers the dimensional aspects of concrete elements at two levels. The first are those required for structural acceptability in accordance with AS 3600. The second relates to the particular surface class and its project documentation.*

It is not the intention of this Standard to recommend that all concrete work should be automatically evaluated. It is expected that these procedures will only be used when there is some doubt about the acceptability of the complete element.

As a performance standard, the emphasis is on the construction process. Accordingly the tolerances are measured on the concrete surface for this is the final product and represents the formwork in its service state, i.e. deflected and distorted under the forces of fluid concrete placement and other construction activity.

The one exception to this is the case where some strain movement of the permanent structure is expected, e.g. slab deflection. In such cases the relevant element needs to be checked while it is still being supported by the formwork.

This Standard covers the methods to be used in the evaluation of the completed concrete elements for acceptance or rejection. It applies to work that has been repaired as well as to the elements that may not require any rectification. This Standard does not limit the number of times that evaluation may be carried out after repair.

For work which is to have the surface treated in some way, e.g. tooled or gritblasted, evaluation will take place when the concrete element has been poured and stripped prior to surface treatment.

The intention of the requirements is to lay down fair procedures for the evaluation of the completed work, and to minimize the number of situations where subjective judgement is required.

Experience has shown that situations where judgement is based on personal opinion, rather than quantitative measurement, are those that lead to disputes and accusations of unfair treatment. However, no set of requirements can possibly cover every circumstance. It is recommended that the project documentation provide guidance on all the critical aspects of each project. It may be necessary to specify extra procedures for particular circumstances. In these cases, it is recommended to avoid, wherever possible, specifications which call for the exercise of discretionary judgement.

3.3.2 Critical face

Where a concrete element has several faces each with an equal class of surface finish, the project documentation shall specify which faces take precedence in the checking of deviations. Where the opposite faces are of different classes then the face with the higher quality shall take precedence in the checking [see Clause 2.2.3(b)(i)].

3.3.3 Surface finish

3.3.3.1 Acceptable criteria

Table 3.3.3.1 specifies the acceptable criteria for surface finish.