



# Residential Footing Design and Reinforcement Quality

© SRIA 2025

Scott Munter, Executive Director/CEO, SRIA



**Web Site: [sria.com.au](http://sria.com.au)**

**Information about the SRIA**

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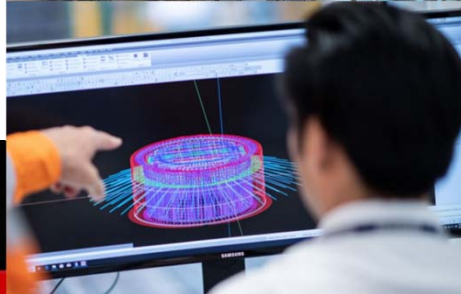
**QUALITY GUARANTEED**  
Look for the SRIA logo  
[LEARN MORE](#)

## Our Objectives

**Member Services**  
**Technical Leadership**  
**Codes, Standards and Regulations**  
**Market Development**

### The Hub for Steel Reinforcement Knowledge and Support

- Quality and Traceability
- Workplace Health and Safety
- Prefabrication
- Australian Manufacturing and Jobs
- Digital Detailing
- Sustainability
- One Stop Shop







# Web Site: [sria.com.au](http://sria.com.au) Has a Wealth of Information



## Technical Publications

### Technical Notes

### Construction Tips and Alerts

### Conference Papers and Presentations

### Lectures

### Research

### Videos

## RAFT SLAB DESIGN AND DETAILING - VICTORIAN STRUCTURAL BRANCH COMMITTEE OF ENGINEERS AUSTRALIA 12 JULY 2016

| Title                         | Description                                                                                           | Size    |
|-------------------------------|-------------------------------------------------------------------------------------------------------|---------|
| Presentation by Peter Bayetto | Compliance with AS2870-2011 - Recent Failure Investigations and Design by Engineering Principles (rev | 23.1 MB |
| Presentation by Eric Lume     | Residential Slabs and Footings Construction Requirements                                              | 6.3 MB  |
| Presentation by Scott Munter  | Residential Slabs and Footings Reinforcement and Slab Design                                          | 7.3 MB  |

# Reinforcing Bar Classification

All reinforcing bar to comply with:

AS/NZS 4671 Steel for the reinforcement of concrete

| AS/NZS 4671 Designation | Yield Stress MPa | Ductility Class | Description              | Typical Size mm                              |
|-------------------------|------------------|-----------------|--------------------------|----------------------------------------------|
| S600N                   | 600              | N               | Hot-rolled Deformed bar  | 11, 15, 18, 22, 26, 29, 33, 37               |
| D500N                   | 500              | N               | Hot-rolled Deformed bar  | Coil (10-20), Straight (12-40), Special (50) |
| R250N                   | 250              | N               | Hot-rolled Plain round   | 6.5, 10, 12, 16, 20, 24                      |
| D250N                   | 250              | N               | Hot-rolled Deformed bar  | 12 (pool steel)                              |
| D500L                   | 500              | L               | Cold-rolled Deformed bar | 5 - 12                                       |
| R500L                   | 500              | L               | Cold-drawn Round rod     | 5 - 12                                       |

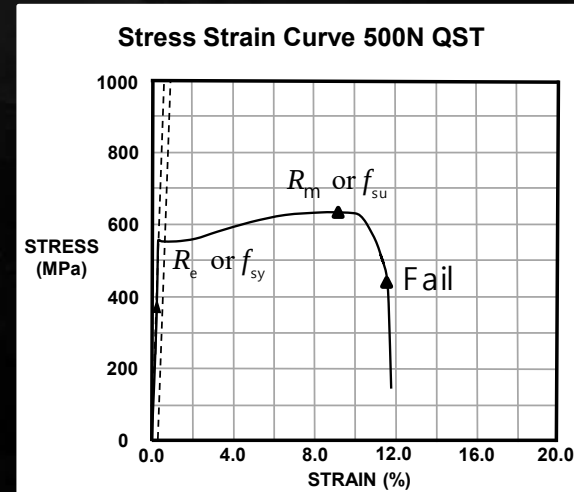
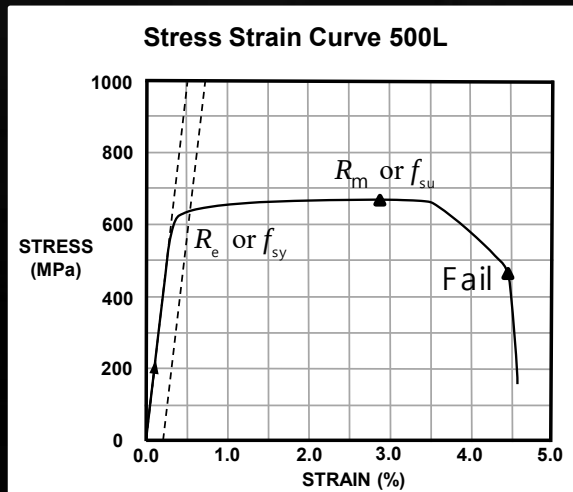
## → Symbols used

- S Deformed Grade 600 Ductility Class N Bars ie S18
- N Deformed Grade 500 Ductility Class N Bars ie N20
- POL Deformed Grade 250 Ductility Class N Bars ie POL 12
- R Plain Round Grade 250 Ductility Class N Bars ie R10
- L Plain Round Grade 500 Ductility Class L Bars ie L10

# Mechanical Properties

## AS/NZS 4671:2019 Steel for the reinforcement of concrete: Table 7.2 (A&B)

| Property               |                          | 250N               | 500L                     | 500N                     | 600N                     | 750N                     | Probability of exceedance                |
|------------------------|--------------------------|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|------------------------------------------|
| Nominal Diameter (mm)  |                          | 12<br>(pool steel) | 5 to 12                  | 10 to 40                 | 10 to 40                 | 8.2, 9.8 & 13            | -                                        |
| Yield Stress (MPa)     | $R_{ek.L}$<br>$R_{ek.U}$ | $\geq 250$<br>-    | $\geq 500$<br>$\leq 750$ | $\geq 500$<br>$\leq 650$ | $\geq 600$<br>$\leq 750$ | $\geq 750$<br>$\leq 900$ | $C_{vL}: P = 0.95$<br>$C_{vU}: P = 0.05$ |
| Ratio                  | $(R_m/R_e)_{k.L}$        | $\geq 1.08$        | $\geq 1.03$              | $\geq 1.08$              | $\geq 1.08$              | $\geq 1.04$              | $C_{vL}: P = 0.90$                       |
| Uniform Elongation (%) | $A_{gt.k.L}$             | $\geq 5.0$         | $\geq 1.5$               | $\geq 5.0$               | $\geq 5.0$               | $\geq 4.0$               | $C_{vL}: P = 0.90$                       |



# Chemical Composition

| Type of analysis | Chemical Composition (%) Max |              |                  |       |                                    |      |             |
|------------------|------------------------------|--------------|------------------|-------|------------------------------------|------|-------------|
|                  | C                            |              | P                | S     | Carbon Equivalence Value for Class |      |             |
|                  | 500L<br>500N                 | 600N<br>750N | All steel grades |       | 500L                               | 500N | 600N & 750N |
| Cast analysis    | 0.22                         | 0.33         | 0.050            | 0.050 | 0.39                               | 0.44 | 0.49        |
| Product analysis | 0.24                         | 0.35         | 0.055            | 0.055 | 0.41                               | 0.46 | 0.51        |



## Carbon Equivalence:

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

**Correct chemistry allows  
welding to AS/NZS 1554.3**

# Ensuring Quality Reinforcement

## JASANZ Accredited Third Party Certification

**2025**  
VALID TO 31 Dec  
Australasian Certification Authority for  
Reinforcing and Structural Steels Ltd



PRODUCT CERTIFICATION  
www.steelcertification.com

**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

This is to certify that  
**InfraBuild Steel**  
at  
22 Kellogg Rd  
Rooty Hill NSW Australia 2766



has satisfied the Authority that it complies with the rules of the ACRS Product Certification Scheme and the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the Standards listed below, and is entitled to use the ACRS mark in relation to the products listed on this certificate.

**SCOPE OF CERTIFICATION**  
**Reinforcing Bar Manufactured in straight lengths to AS/NZS 4671:2019**

Products listed on this Manufactured Product certificate may be relied upon as having the benefit of ACRS Product Scheme certification after any subsequent processing only if cut, or bent, or welded by an ACRS certified processor. For Approval of processed reinforcing bar, refer to the bar processor's ACRS Fabricated Product certificate.

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority.

| CERTIFICATE NUMBER | VERSION | FIRST APPROVAL   | ISSUE DATE      | EXPIRY DATE      |
|--------------------|---------|------------------|-----------------|------------------|
| 31101              | 4       | 01 November 2003 | 01 January 2025 | 31 December 2025 |

SIGNED FOR ACRS



Andrew Wheeler,  
Executive Director  
AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL  
STEELS LTD | ABN: 40 096 692 545 | PO BOX 1369, CROWS NEST NSW 1585, AUSTRALIA

To check the validity of this certificate please scan the above Static QR Code with the ACRS  
Cloud App or visit [www.steelcertification.com](http://www.steelcertification.com)

Cert. Ref: 001-07 31101

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www.jas-anz.org/register  
Accreditation certificate  
number Z5221212AC

PRINTED ON 23/12/2024 FROM ACRS

### Example of a JASANZ Accredited 3<sup>rd</sup> Party Mill Certificate

Certifies the stock bar, rod and coiled products conform to AS/NZS 4671

**Straight Bar Manufactured to AS/NZS 4671:2019**  
**Manufactured Bars listed on the ACRS Certificate,**  
**only remain ACRS Certified if cut, or bent, or welded**  
**by an ACRS certified processor.**

**For Approval of processed reinforcing bar,**  
**refer to the bar processor's**  
**ACRS Fabricated Product certificate.**

JASANZ  
Joint Accreditation System of  
Australia and New Zealand



# Ensuring Quality Reinforcement

## Need for a JASANZ Accredited Third Party Certificate

Every project should specify one and obtain to guarantee quality



# Ensuring Quality Reinforcement

## JASANZ Accredited 3<sup>rd</sup> Party Processor Certificate

Required by purchasers to prove quality reinforcement delivered to site



**2025**  
VALID TO 31 Dec  
Australasian Certification Authority for  
Reinforcing and Structural Steels Ltd



**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

Certificate No: 811021  
Ausreo Pty Ltd  
at  
Gate C, 133/139 Newton Rd  
Wetherill Park NSW Australia 2164



**Products assessed by ACRS to the following Standards:**

- Processing and distribution of Grade 250N and 500N carbon steel bars and welded mesh in accordance with AS/NZS 4671: 2019, and either AS 3600: 2018 Concrete structures and AS 5100.5: 2017 Bridge design – Concrete “material and construction requirements for reinforcing steel”, or the “Reinforcement” clauses of NZS 3109 Concrete Construction.
- Threading of reinforcing bar for the application of a Lenton Coupler with equipment, training and maintenance provided by the supplier.

Processed steel reinforcing materials may only be relied upon as having the benefit of ACRS Product Scheme certification when manufactured or processed by ACRS certificate holders.

**Approved Company Information**

Tag



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Cert. Ref.: 021-01 811021

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[www.jas-anz.org/register](http://www.jas-anz.org/register)  
Accreditation certificate  
number Z5021312AC

ACRS Processor Certificate only available if reinforcement supplied by ACRS Certified Mill

*Processing of Grade 250N and 500N carbon steel bars and welded mesh in accordance with AS/NZS 4671 (2019) and either:*

- *AS 3600 (2018) Concrete structures*
- *AS 5100.5 Bridge design – Concrete*
- *NZS 3109 Concrete Construction*

# Bending Reinforcement

Clause 17.2.3.2 of AS 3600 – required pin diameters

**Avoids excessive steel strain and crushing of concrete**

## Fitments

500L & R250N

$3d_b$

D500N

$4d_b$

## General

D500N

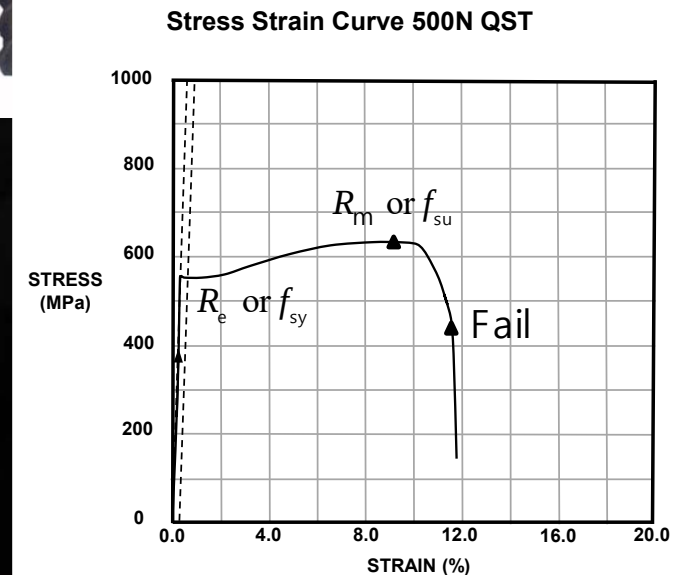
$5d_b$

Galvanised  $\leq 16\text{mm}$

$5d_b$

Galvanised  $\geq 20\text{mm}$

$8d_b$



# Ensuring Quality Reinforcement

## Need for a JASANZ Accredited Third Party Certificate

Every project should specify one and obtain to guarantee quality



@TruthAbtChina

# Ensuring Quality Reinforcement

Recent increase in imported mesh product



# SRIA Industry Warning late 2023

For updates connect with SRIA on social media: LinkedIn Facebook Instagram



WARNING WARNING WARNING WARNING WARNING WARNING

## INDUSTRY WARNING!

**Imported NON-COMPLIANT STEEL MESH is being sold to unsuspecting customers**

The unique markings on the longitudinal and crossbars of the mesh do not match the markings on the quality certificate sent to the customer.

**Two options to protect yourself:**

1. Verify the markings on the mesh  
**MATCH the markings on the certificate.**  
If they don't match, return the mesh to the supplier as non-conforming product.
2. Buy steel mesh from a SRIA member.  
ALL SRIA members hold current JASANZ accredited 3rd party certification to prove their mesh conforms to AS/NZS 4671.  
[Click to view our members](#)



[Click to view certification](#)

Since 1988, it's been our duty to support reinforcing steel quality and capability in Australia. **Don't take the risk of having to replace the building or structure because you used non-conforming steel mesh.**

WARNING WARNING WARNING WARNING WARNING WARNING



**SRIA** Steel Reinforcement Institute of Australia  
sria.com.au

## NON – CONFORMING MESH CAMPAIGN RAISING AWARENESS ON SOCIAL MEDIA



David Chandler OAM • Following

2w \*\*\*

NSW Building Commissioner at NSW Department of Customer Service

[#BuildingCommissionNSW](#) will be keeping an eye out. [#Engineers](#) [#Certifiers](#) [#Builders](#) expect check-ups of [#OccupationCertificates](#) and on-site. Will be an avoidable tragedy to have to demolish slabs if found. Be assured if counterfeit products are discovered they will be coming out. [#BuildingCompliance](#) [#Accountability](#) [#Licences](#) [#Risk](#)

Like ·    84 | Reply · 8 Replies

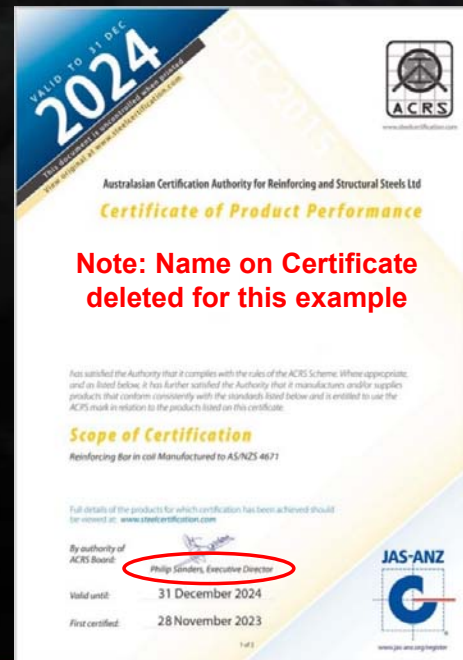


# Ensuring Quality Reinforcement

## Products found accompanied with false ACRS Certificates

- ➔ Always check Certificates on JASANZ website
- ➔ This company (logo removed) was a non-Australia producer for >10 years
- ➔ Printed copies may have been altered
- ➔ SRIA Member's Certificates can be found on SRIA website

Philip Sanders resigned as Executive Director some years prior to this Certificate



# Ensuring Quality Reinforcement

On Site – check that bar markings match the JASANZ 3<sup>rd</sup> party Certificate

➔ Bar marking



➔ ACRS Certificate for imported mesh

**2023**  
VALID TO 31 Dec  
Australasian Certification Authority for  
Reinforcing and Structural Steels Ltd

**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

This is to certify that  
**Tianjin TianKang Metal Products Co. Ltd**  
at  
Tuanbo,  
Jinghai County Tianjin China

has satisfied the Authority that it complies with the rules of the ACRS Product Certification Scheme and the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the standards listed below, and is entitled to use the ACRS mark in relation to the products listed on this certificate.

**SCOPE OF CERTIFICATION**  
Steel Reinforcing Mesh Manufacture to AS/NZS 4671:2019

Mesh approved on this certificate is certified only if manufactured from ACRS approved wire or bar. For approval of wire or bar, please refer to the manufacturer's ACRS certificate.  
This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority.

| CERTIFICATE NUMBER | VERSION | FIRST APPROVAL   | ISSUE DATE      | EXPIRY DATE      |
|--------------------|---------|------------------|-----------------|------------------|
| 160802             | 2       | 30 November 2016 | 01 January 2023 | 31 December 2023 |

SIGNED FOR ACRS

  
Andrew Wheeler,  
Executive Director  
AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL  
STEELS LTD | ABN: 40 096 692 545 | PO BOX 1369, CROWS NEST NSW 1585, AUSTRALIA

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Cloud App or [www.steelcertification.com](http://www.steelcertification.com)

Cert. Ref.: 082-01 160802 2

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Accreditation certificate  
number Z5221212AC

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**2023**  
VALID TO 31 Dec  
Australasian Certification Authority for  
Reinforcing and Structural Steels Ltd

**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

Certificate No: 160802  
**Tianjin TianKang Metal Products Co. Ltd**  
at  
Tuanbo,  
Jinghai County Tianjin China

**Products assessed by ACRS to the following Standards:**  
AS/NZS 4671 Grade 500L Mesh  
• Square Mesh SL52, SL62, SL63\*, SL72, SL81\*, SL82, SL92, SL102  
• Trench Mesh L8TM, L11TM, L12TM  
Non Structural Mesh (NZ): SL41.5, SL51.5

\*added July 2023

**Approved Company Information**

**Bar Markings**

Tianjin TianKang Industrial Corporation

**Tag**



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Accreditation certificate  
number Z5221212AC

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Tag on mesh?

天津天康金属制品有限公司

产品名称: 钢筋网片

产品规格: SL72

执行标准: AS/NZS 4671

订单合同号: -266

数量: 305

标识号: 2560/304A

**SRIA**  
Steel Reinforcement  
Institute of Australia

# Ensuring Quality Reinforcement

## ACRS Certificate updated after questions raised

- ➔ Bar marking now matches 'interim' 2023/2024 image
- ➔ Always buy from a JASANZ 3<sup>rd</sup> party accredited mill for traceability



**2024**  
VALID TO 31 Dec  
Australasian Certification Authority for  
Reinforcing and Structural Steels Ltd

  
  
PRODUCT CERTIFICATION  
www.steelcertification.com

**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

This is to certify that  
**Tianjin TianKang Metal Products Co., Ltd.**  
at  
Zhangjia Fangzi Village,  
Tuanbo Town, Jinghai County, Tianjin China 301636  
has satisfied the Authority that it complies with the rules of the ACRS Product Certification Scheme and the relevant  
ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it has further  
satisfied the Authority that it manufactures and/or supplies products that conform with the Standards listed below,  
and is entitled to use the ACRS mark in relation to the products listed on this certificate.

**SCOPE OF CERTIFICATION**  
**Steel Reinforcing Mesh Manufacture to AS/NZS 4671:2019**  
Mesh approved on this certificate is certified only if manufactured from ACRS approved wire or bar. For approval of  
wire or bar, please refer to the manufacturer's ACRS certificate.  
This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority.

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|--------------------|---------|------------------|-----------------|------------------|
| 160802             | 4       | 30 November 2016 | 01 January 2024 | 31 December 2024 |

SIGNED FOR ACRS  
  
Andrew Wheeler,  
Executive Director  
AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL  
STEELS LTD | ABN: 40 096 692 545 | PO BOX 1369, CROWS NEST NSW 1585, AUSTRALIA

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PRODUCT CERTIFICATION  
www.steelcertification.com

**CERTIFICATE OF APPROVAL**  
Product Conformity Certification

Certificate No: 160802  
**Tianjin TianKang Metal Products Co., Ltd.**  
at  
Zhangjia Fangzi Village,  
Tuanbo Town, Jinghai County, Tianjin China 301636

Products assessed by ACRS to the following Standards:

**AS/NZS 4671 Grade 500L Mesh**

- Square Mesh SL52, SL62, SL63, SL72, SL81, SL82, SL92, SL102
- Trench Mesh L8TM, L11TM, L12TM
- Rectangular Mesh RL718, RL818, RL918, RL1018 and RL1218

Non Structural Mesh (NZ): SL41.5, SL51.5

Approved Company Information

Bar Markings  
  
Tianjin TianKang Industrial Corporation

Tag  


To check the validity of this certificate please scan the above Static QR Code with the ACRS  
Cloud App or visit [www.steelcertification.com](http://www.steelcertification.com)

Cert. Ref.: 082-01 160802 4

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Accreditation certificate  
number Z5221212AC

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# Ensuring Quality Reinforcement

- Either:**
1. Buy from an SRIA Member – All JASANZ accredited 3<sup>rd</sup> Party Certified
  2. Obtain JASANZ accredited 3<sup>rd</sup> Party Mill & Processor Certificates  
Check that Certificates are authentic  
([register.jasanz.org/certified-organisations](http://register.jasanz.org/certified-organisations) and search for AS/NZS 4671)
  3. Ensure tags/bar markings match the Certificate when inspecting



**ASK THE QUESTION  
WHO SUPPLIED  
THE REO?**

**SRIA MEMBERS MUST HAVE  
3RD PARTY PROCESSOR CERTIFICATION**

The Steel Reinforcement Institute of Australia advocates for  
**QUALITY GUARANTEED.**

Support the processors who invest in the safety of  
Australia's building and construction industry,  
not the ones who simply want to extract profits from it.

**LOOK FOR THE SRIA LOGO**

**SRIA**

IT'S YOUR GUARANTEE OF REBAR PRODUCT CONFORMANCE

[sria.com.au](http://sria.com.au)

**SRIA**  
Steel Reinforcement  
Institute of Australia

# Surface Condition of Reinforcement

## Ensure no loose or flaking rust on surface of bar

- ➔ Indicates loss of steel section (or mass) which may affect performance
- ➔ Limits on mass provided in Table 7.5 (A) of AS/NZS 4671
- ➔ If outside these limits, then non-conforming
- ➔ Refer also **SRIA Technical Note 1**

## Acceptable – surface corrosion



## Unacceptable Loose and flaking rust



N20 Bar



SL72 Mesh



# Bending Reinforcement on Site

## Incorrect Site Practices

### Not bending around correct pin diameter

- ➔ Site rebending now covered by Clause 17.2.3.2 of AS 3600 (2018) due to poor site practices
- ➔ Use of pipes for leverage no longer allowed in AS 3600 due to a lack of control on site
- ➔ Refer also **SRIA Technical Note 4**



# Bending Reinforcement on Site

## Recommend bars bent properly by Processor

Take care in approving site bent reinforcement



Bends up to 180  
Maximum D16 bar  
35 - 63 mm bending roller  
Depends on brand and model



Bends of  
90, 135 and 180  
Max D20 bar  
Roller diameter?



Bends  
45, 90, 135 & 180  
Roller  
38, 50 & 62  
Max N20 bar

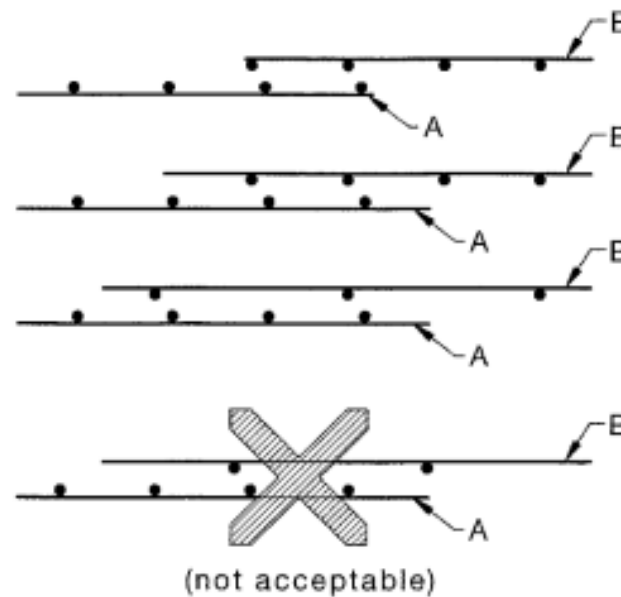
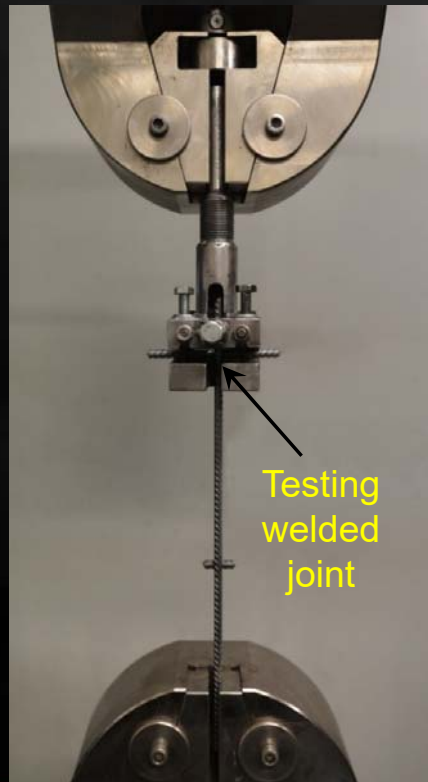


Bends 90  
Max N20 bar

# Mesh Processing

## Quality of welding and adequate lap are critical

- ➔ Each welded joint develops 50% of the bar's yield stress
- ➔ Clause 7.2.5 of AS/NZS 4671
- ➔ Overlap mesh sheets a minimum of 2 cross-bars



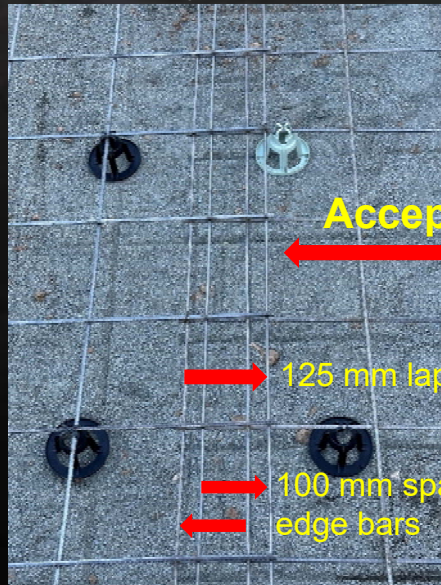
NOTE: The wire orientation is illustrative only.

Figure 6.5 of CIA Handbook  
Figure 5.1 from AS 2870

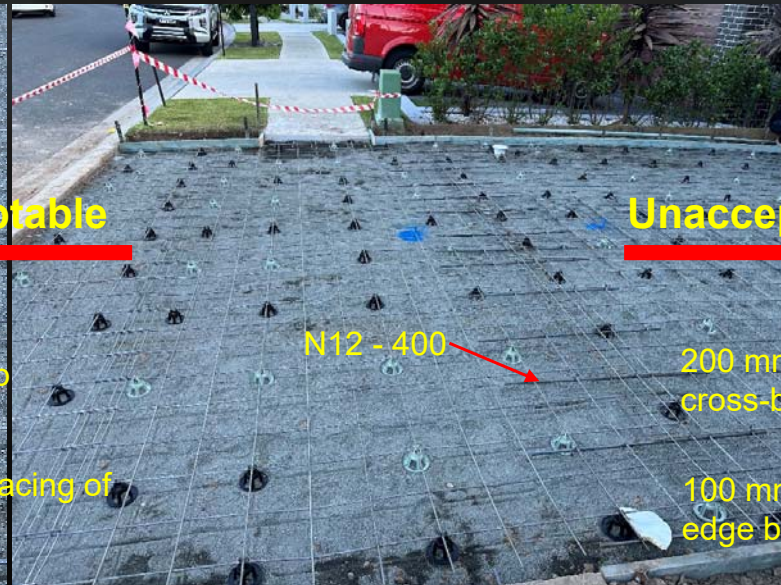
# Lapping of Mesh

**Overlap mesh sheets a minimum of 2 cross-bars**

Lapped by 2 cross-bars



B A B A



Lapped by 1 cross-bar



B A A B

A bar should have been here

Note: Concreter on project taught to overlap mesh by 125 mm

# National Construction Code Requirements

## Performance Requirements

### H1P1 Structural reliability and resistance

[2019: P2.1.1]

- (1) By resisting the actions to which it may reasonably be expected to be subjected, a building or structure, during construction and use, with appropriate degrees of reliability, must—
- (a) perform adequately under all reasonably expected design actions; and
  - (b) withstand extreme or frequently repeated design actions; and
  - (c) be designed to sustain local damage, with the structural system as a remaining stable and not being damaged to an extent disproportionate to the original local damage; and
  - (d) avoid causing damage to *other properties*.

# National Construction Code Requirements

## NCC Performance requirements

(2) The actions to be considered to satisfy (1) include but are not limited to—

- (a) permanent actions (dead loads); and
- (b) imposed actions (live loads arising from occupancy and use); and
- (c) wind action; and
- (d) earthquake action; and
- (e) snow action; and
- (f) liquid pressure action; and
- (g) ground water action; and
- (h) rainwater action (including ponding action); and
- (i) earth pressure action; and
- (j) differential movement; and
- (k) time dependent effects (including creep and shrinkage); and
- (l) thermal effects; and
- (m) ground movement caused by—
  - (i) swelling, shrinkage or freezing of the subsoil; and
  - (ii) landslip or subsidence; and
  - (iii) siteworks associated with the building or structure; and
- (n) *construction activity actions*; and
- (o) termite actions.

# National Construction Code Requirements

## NCC Performance requirements

- (3) The structural resistance of materials and forms of construction must be determined using five percentile characteristic material properties with appropriate allowance for—
- (a) known construction activities; and
  - (b) type of material; and
  - (c) characteristics of the site; and
  - (d) the degree of accuracy inherent in the methods used to assess the structural behaviour; and
  - (e) action effects arising from the differential settlement of foundations, and from restrained dimensional changes due to temperature, moisture, shrinkage, creep and similar effects.

### H1D1 Deemed-to-Satisfy Provisions

[New for 2022]

- (1) Where a *Deemed-to-Satisfy Solution* is proposed, *Performance Requirements* H1P1 and H1P2 are satisfied by complying with H1D2 to H1D11.
- (2) Where a *Performance Solution* is proposed, the relevant *Performance Requirements* must be determined in accordance with A2G2(3) and A2G4(3) as applicable.

# AS 2870 Section 1: Scope and General

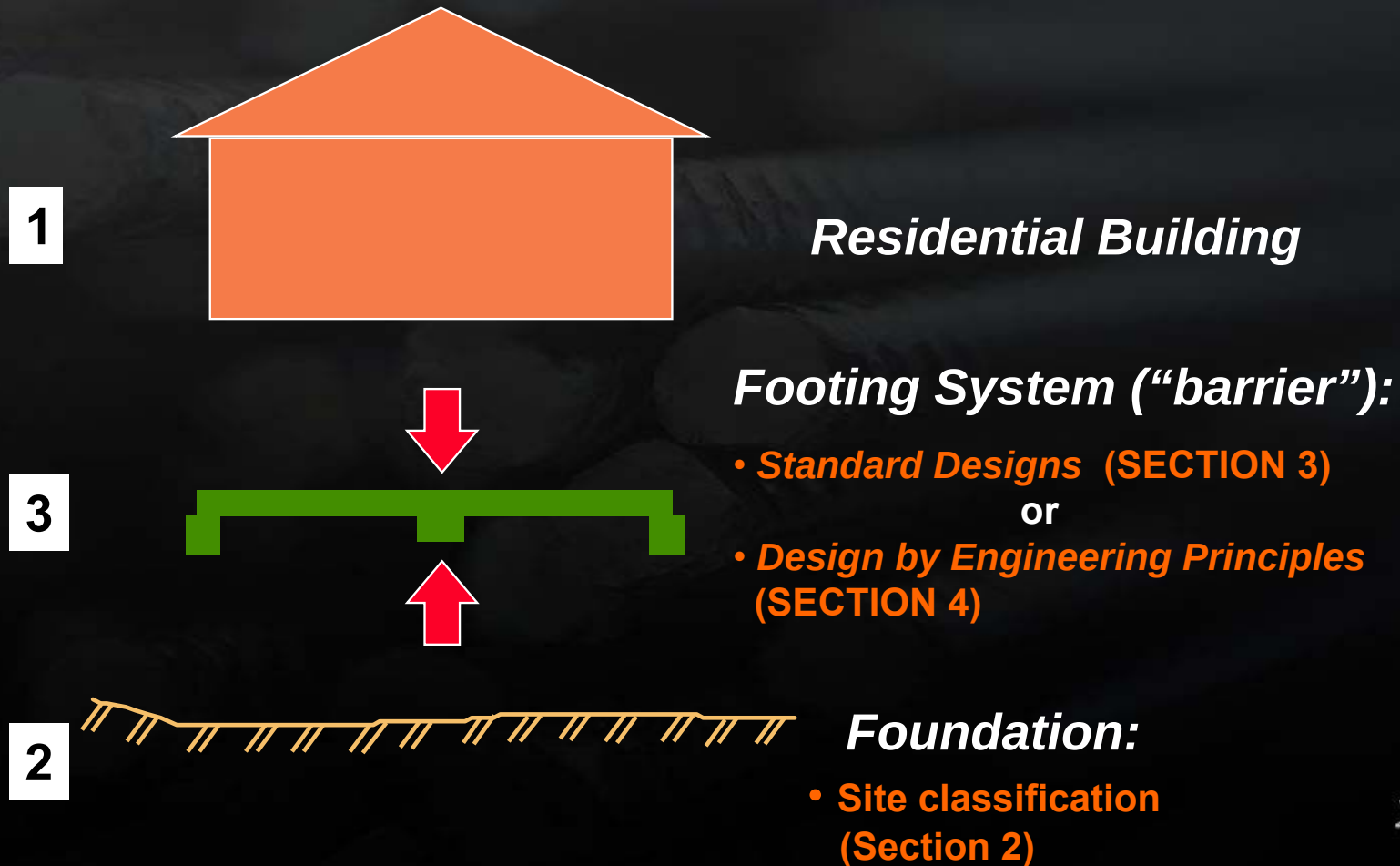
## 1.2 APPLICATION

To comply with this Standard:

- (a) all sites shall be classified in accordance with Section 2; &
- (b) footing system design shall be performed by either:
  - (i) prescribing a standard design in accordance with Section 3; or
  - (ii) applying the engineering principles described in Section 4; &
- (c) all design and construction shall comply with Sections 5 and 6.

**Residential concrete footing system design, detailing and construction should also comply with AS 3600, except that if in conflict, AS 2870 takes precedence.**

# AS 2870: Design Process



# AS 2870 Section 3: Standard Designs

- DTS Designs - calibrated empirically by observing the real performance and reserve strength of completed buildings.
- Less emphasis on design loads & greater emphasis on foundation movement
- Clause 1.4.2 - design actions are:
  - ➔  $1.0 \times \text{Foundation movement} + 1.0 \times \text{Permanent action (DL)} + 0.5 \times \text{Imposed action (LL)}$
- Why this design philosophy?
  - ➔ Foundation movement is a primary design consideration for footing systems which act as a “*barrier*” to protect the structure they support.
  - ➔ Less emphasis given to dead and live loads reduces overall cost of housing nationally.
  - ➔ Failure due to overloading poses only a minimal or nonexistent risk to life.
- The minimum requirements will not necessarily result in a defect-free building, as stated in Clause 1.3.1.

# AS 2870 Section 3: Standard Designs

| Site class | Type of construction       | Edge and internal beams |                      |                 |                       |                       |
|------------|----------------------------|-------------------------|----------------------|-----------------|-----------------------|-----------------------|
|            |                            | Depth (D) mm            | Bottom reinforcement |                 | Top bar reinforcement | Max beam spacing cc m |
|            |                            |                         | Mesh                 | Bar alternative |                       |                       |
| Class A    | Clad frame                 | 300                     | 3-L8TM               | 2N12            | -                     | -                     |
|            | Articulated masonry veneer | 300                     | 3-L8TM               | 2N12            | -                     | -                     |
|            | Masonry veneer             | 300                     | 3-L8TM               | 2N12            | -                     | -                     |
|            | Articulated full masonry   | 400                     | 3-L8TM               | 2N12            | -                     | -                     |
| Class S    | Clad frame                 | 300                     | 3-L8TM               | 2N12            | -                     | -                     |
|            | Articulated masonry veneer | 300                     | 3-L8TM               | 2N12            | -                     | -                     |
|            | Masonry veneer             | 300                     | 3-L11TM              | 3N12            | -                     | -                     |
|            | Articulated full masonry   | 500                     | 3-L11TM              | 3N12            | 2N12                  | 5                     |
| Class M    | Clad frame                 | 300                     | 3-L11TM              | 3N12            | -                     | 6                     |
|            | Articulated masonry veneer | 400                     | 3-L11TM              | 3N12            | -                     | 6                     |
|            | Masonry veneer             | 400                     | 3-L11TM              | 3N12            | -                     | 5                     |
|            | Articulated full masonry   | 625                     | 3-L11TM              | 3N12            | 2N12                  | 4                     |
| Class M-D  | Clad frame                 | 950                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
|            | Articulated masonry veneer | 400                     | 3-L11TM              | 3N12            | -                     | 5                     |
|            | Masonry veneer             | 400                     | 3-L11TM              | 3N12            | 1N12                  | 4                     |
|            | Articulated full masonry   | 500                     | 3-L12TM              | 3N12            | 2N12                  | 4                     |
| Class H1   | Clad frame                 | 650                     | 3-L11TM              | 2N16            | 2N16                  | 4                     |
|            | Articulated masonry veneer | 1050                    | 2x3-L11TM            | 3N16            | 3N16                  | 4                     |
|            | Masonry veneer             | 400                     | 3-L11TM              | 3N12            | -                     | 5                     |
|            | Articulated full masonry   | 400                     | 3-L11TM              | 3N12            | 1N12                  | 4                     |
| Class H1-D | Clad frame                 | 500                     | 3-L11TM              | 3N12            | 3N12                  | 4                     |
|            | Articulated masonry veneer | 650                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
|            | Masonry veneer             | 800                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
|            | Articulated full masonry   | 1100                    | 2x3-L12TM            | 3N16            | 3N16                  | 4                     |
| Class H2   | Clad frame                 | 400                     | 3-L11TM              | 3N12            | 1N12                  | 4                     |
|            | Articulated masonry veneer | 500                     | 3-L11TM              | 3N12            | 2N12                  | 4                     |
|            | Masonry veneer             | 600                     | 2x3-L11TM            | 3N12            | 2N12                  | 4                     |
|            | Articulated full masonry   | 750                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
| Class H2-D | Clad frame                 | 1000                    | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
|            | Articulated masonry veneer | -                       | -                    | -               | -                     | -                     |
|            | Masonry veneer             | 550                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |
|            | Articulated full masonry   | 700                     | 2x3-L11TM            | 3N16            | 2N16                  | 4                     |

Standard Designs – Figure 3.1 (in part)

- Section 3 Deem-to-comply 'recipe' footing system designs cover most sites (except Class E & P)
- Maximum differential footing deflection (i.e. serviceability) is specified for the design of footing & rafts in Table 4.1
- Limits damage depending on sensitivity and type of supported elements e.g. masonry.
- Slabs & footings modelled as beams or rafts supported on a foundation are indeterminate systems.
- Software is an efficient modelling tool and has been used to check Section 3 design models to Section 4 engineering principles.
- One such program is 'CORD' – Code Orientated Raft Design, a commercial footing design program.



# AS 2870 Section 3: Standard Designs

Standard reinforcement designs satisfy the following criteria (of Section 4):

## **BENDING STRENGTH (cross-section design): Clause 4.4 (f)**

- $M^* \leq \phi M_u$ 
  - ➔  $M_u$  = nominal moment capacity calculated in accordance with AS 3600, e.g.  $f_{sy}=500$  MPa
  - ➔  $\phi$  = capacity reduction factor (**NOTE:**  $\phi=0.85$  for both Class L & N steels in AS 2870)

## **SHEAR STRENGTH (region design, e.g. punching shear): Clause 4.4 (j)**

- $V^* \leq \phi V_u$ 
  - ➔  $V_u$  = nominal shear capacity (with or without shear reo) calculated in accordance with AS 3600
  - ➔  $\phi$  = capacity reduction factor ( $\phi=0.7$  for both Class L & N steels)

## **DUCTILITY (overall member design): Clause 4.4(i)**

- $M_u \geq 1.2M_{cr}$  (minimum bending strength for multiple crack development)
  - ➔ flexural cracking moment,  $M_{cr}$  (for  $f'_c = 20$  MPa : sagging  $f_t = 2.7$  MPa; hogging  $f_t = 1.8$  MPa)

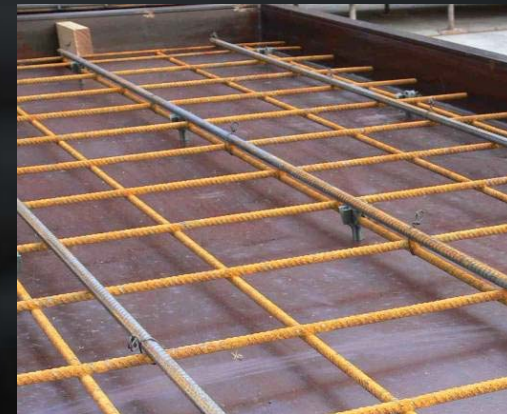
**NOTE:** All standard footing designs developed with:

- ➔  $\phi = 0.85$  (flexure) or 0.7 (shear) for Ductility Class L & N steels.

# Mixing Ductility Class L & N Steels

If mixing Ductility Class L & N steels together in a single layer, for AS 2870 footing designs they are treated as fully equivalent:

- $\phi = 0.85$  to calculate  $\phi M_u$ 
  - ➔ Moment redistribution is not normally assumed when calculating  $M^*$ , which reduces ductility demand on the reinforcing steel
  - ➔ No imminent warning requirements
  - ➔ Sections normally under-reinforced
  - ➔ When calculating nominal moment capacity,  $M_u$ , assume all steel is at yield stress,  $f_{sy} = 500$  MPa
- $\phi = 0.7$  to calculate  $\phi V_u$ 
  - ➔ When calculating nominal shear capacity excluding contribution of shear reinforcement,  $V_{uc}$ , for example, all fully-anchored Class L & N main bars are fully effective, i.e. use full cross-sectional area.



**Class N bars and Class L  
mesh effectively in a  
SINGLE LAYER**

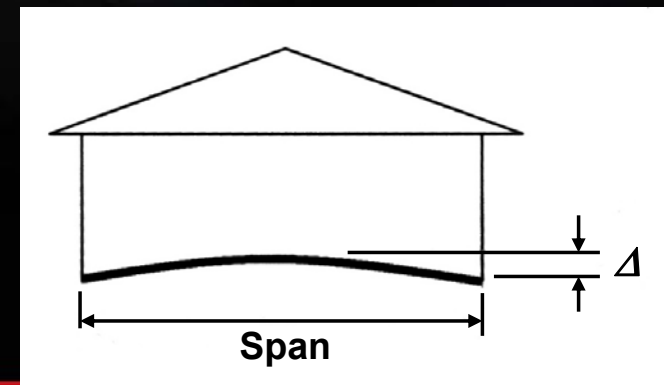
# AS 2870 Section 3: Standard Designs

Greatest ductility demand is in Clad or Articulated Masonry Veneer

Maximum Design Differential Footing Deflection for  
Design of Footings and Rafts (Table 4.1)

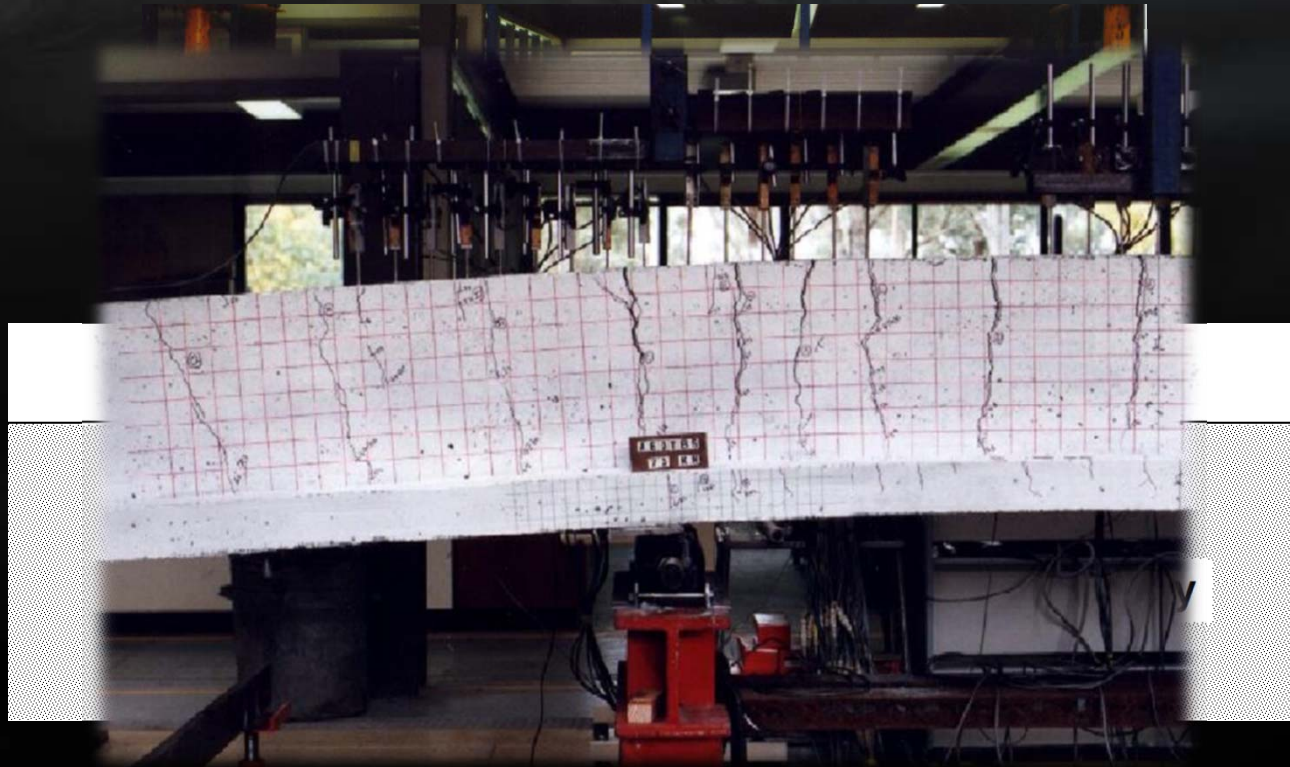
| Type of construction       | Maximum differential deflection, as a function of span, mm | Maximum differential deflection, mm |
|----------------------------|------------------------------------------------------------|-------------------------------------|
| Clad Frame                 | $L/300$                                                    | 40                                  |
| Articulated masonry veneer | $L/400$                                                    | 30                                  |
| Masonry veneer             | $L/600$                                                    | 20                                  |
| Articulated full masonry   | $L/800$                                                    | 15                                  |
| Full masonry               | $L/2000$                                                   | 10                                  |

**NOTE: Deeper (stiffer) members are required as the design differential deflection reduces. Their ductility is less, but so is the ductility demand.**



# AS 2870 Section 3: Standard Designs

These deformations can be accommodated by the ductility of the reinforced-concrete sections incorporating either Class L or N reinforcing steel provided they are designed for multiple cracking.



# AS 2870 Section 4: Modification of Standard Design

**Clause 4.1 GENERAL:** *“This Section may be used to extend the range of validity of, or modify, the deemed-to-comply designs contained in Section 3...”*

## Simplified Method (Clause 4.5)

### Design parameters within the following range (Clause 4.5.1)

| Design Parameter          | Range                                                                                                                                                         |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $y_s$                     | 10 mm to 70 mm if $H_s > 3$ m or<br>10 mm to 100 mm if $H_s < 3$ m                                                                                            |
| $\Delta$                  | 5 mm to 50 mm                                                                                                                                                 |
| Span                      | 5 m to 30 m                                                                                                                                                   |
| Beam spacing              | $\leq 1.25$ values in Figure 3.1<br>Clause 5.3.9 shall apply at external corners of the building.<br>For Class E sites the beam spacing shall not exceed 5 m. |
| Beam depth                | 250 mm to 1200 mm                                                                                                                                             |
| Minimum depth of any beam | $\geq 0.8$ max. beam depth                                                                                                                                    |
| Beam width                | 110 mm to 400 mm                                                                                                                                              |
| Design distributed load   | $\leq 10$ kPa                                                                                                                                                 |
| Design edge line load     | $\leq 25$ kN/m                                                                                                                                                |

# AS 2870 Section 4: Design by Engineering Principles

**Clause 4.5.2:** “...strength shall be provided by the satisfaction of the ductility requirements of Clause 4.4(i)”

## Ductility Requirements & Durability:

- Satisfying the ductility requirement  $M_u \geq 1.2M_{cr}$  allows multiple cracks to form over any zone under a high degree of bending.
  - ➔ Concrete block elements form between adjacent cracks, spaced approximately  $D$  apart, providing a mechanism for greater overall member deformation
- Multiple cracking in peak moment regions avoids concentrating the crack width at the first-cracked section.
  - ➔ With 3-4 cracks forming in each peak region, more rotation is achieved as demanded by the soil movement, etc., and finer cracks normally maintain durability
  - ➔ e.g. 1 crack 0.6 mm wide can be visually a problem, damage finishes or be a corrosion issue, while 3 fine cracks each 0.2 mm wide is good design.
- Class L and N reinforcing steels complying to AS/NZS 4671 have sufficient ductility to ensure adequate deformation capacity.

# AS 2870 Section 4: Design by Engineering Principles

## Reinforcement Requirements for Higher Concrete Grade:

- Standard Section 3 footing designs are all based on  $f'_c = 20\text{MPa}$  and **do not** apply for concrete grades of 32 MPa or greater.
- Higher grade concretes may be required e.g. saline conditions.
- Tensile strength and modulus of elasticity will both increase in proportion to the square root of compressive strength grade,  $f'_c$ .

| Concrete grade | Modulus of elasticity E<br>MPa | Tensile strength<br>Hogging deformation MPa | Tensile strength<br>Sagging deformation MPa |
|----------------|--------------------------------|---------------------------------------------|---------------------------------------------|
| N20            | 15000                          | 1.8                                         | 2.7                                         |
| N25            | 16800                          | 2.0                                         | 3.0                                         |
| N32            | 19000                          | 2.3                                         | 3.4                                         |
| N40            | 21200                          | 2.5                                         | 3.8                                         |

- **If concrete sections remain unchanged, then designers must calculate the steel reinforcement required to satisfy ductility, i.e.  $M_u \geq 1.2M_{cr}$ .**

# Importance of Site Inspections



- Approval of engineering design & specification requirements.
- Ensure quality materials used
- Site inspection is essential before any concrete placement.
- Take photographs and watch start of a concrete pour if there are concerns.



# Industry Issues Identified with AS 2870

## Proposed revision of AS 2870 (2011)

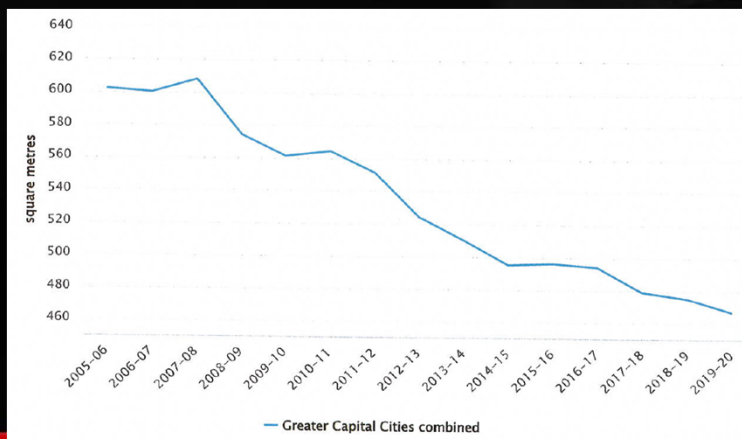
To address problem areas identified since 2011 revision, including:

- ➔ Footing performance
- ➔ Normal and abnormal sites (weather + zero lot alignments)
- ➔ Site classification – impacts of construction
- ➔ More guidance for Class P sites
- ➔ Guidance for concrete strengths > 25 MPa
- ➔ Include high strength reinforcement
- ➔ Review reinforcement detailing requirements
- ➔ Review plumbing requirements
- ➔ Designing for trees (currently informative Appendix)

# Revision of AS 2870

## Normal and Abnormal Sites

- ➔ Add new abnormal moisture conditions
- ➔ Condition identifying and treating initially desiccated sites
- ➔ Zero lot alignment sites
- ➔ Smaller lot sizes
- ➔ Requirement for trees
- ➔ Site classification P
- ➔ More guidance for Class P sites



ABS  
Released 8-9-2020

# Revision of AS 2870

## Site Classification

- ➔ Undertaken by suitably qualified people
- ➔ More reliable classification in difficult or non-standard conditions
- ➔ Currently number of boreholes not specified
- ➔ Extent of investigation not covered
- ➔ Tree removal during land development (use satellite imagery)
- ➔ Basements
- ➔ Changes to classification if backfill and drainage not adequate



# Revision of AS 2870

## Guidance for Class P Sites

- ➔ Currently no guidance provided
- ➔ Guidance will provide more standard approach
- ➔ Reduce the number of sites outside scope of Standard
- ➔ Provide more economical footing designs for Class P sites

## Concrete Strengths > 25 MPa

If concrete strength > 25 MPa

- ➔ Ductility requirements of Clause 4.4(i) need to be satisfied
- ➔ Provide additional Tables to cover 32 MPa and 40 MPa concretes

## High Strength Reinforcement

Include use of 600 MPa reinforcement

# Revision of AS 2870

## Plumbing Requirements

- ➔ Review existing requirements for flexible connections
- ➔ Consider encasement for Class E
- ➔ Ensure consistency with plumbing Standard

## Designing for Trees

- ➔ Trees and reduced boundary distances
- ➔ Normal and abnormal sites (weather and zero lot alignments)



# Revision of AS 2870

## Reinforcement Detailing Requirements

Items to be reviewed and/or included:

- ➔ Mesh lapping requirements
- ➔ Ensure edge bar located along slab edges
- ➔ Bending of reinforcement on site (Tech Note 4)
- ➔ Surface condition of reinforcement (Tech Note 1)
- ➔ Lap lengths (Tech Note 7)
- ➔ Cover set using bar chairs
- ➔ Include AS/NZS 2425 reference
- ➔ Bar chair spacing (Tech Note 3)



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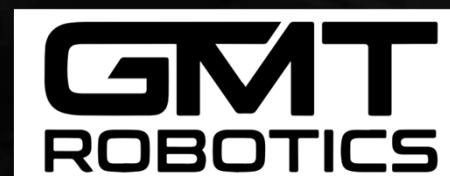
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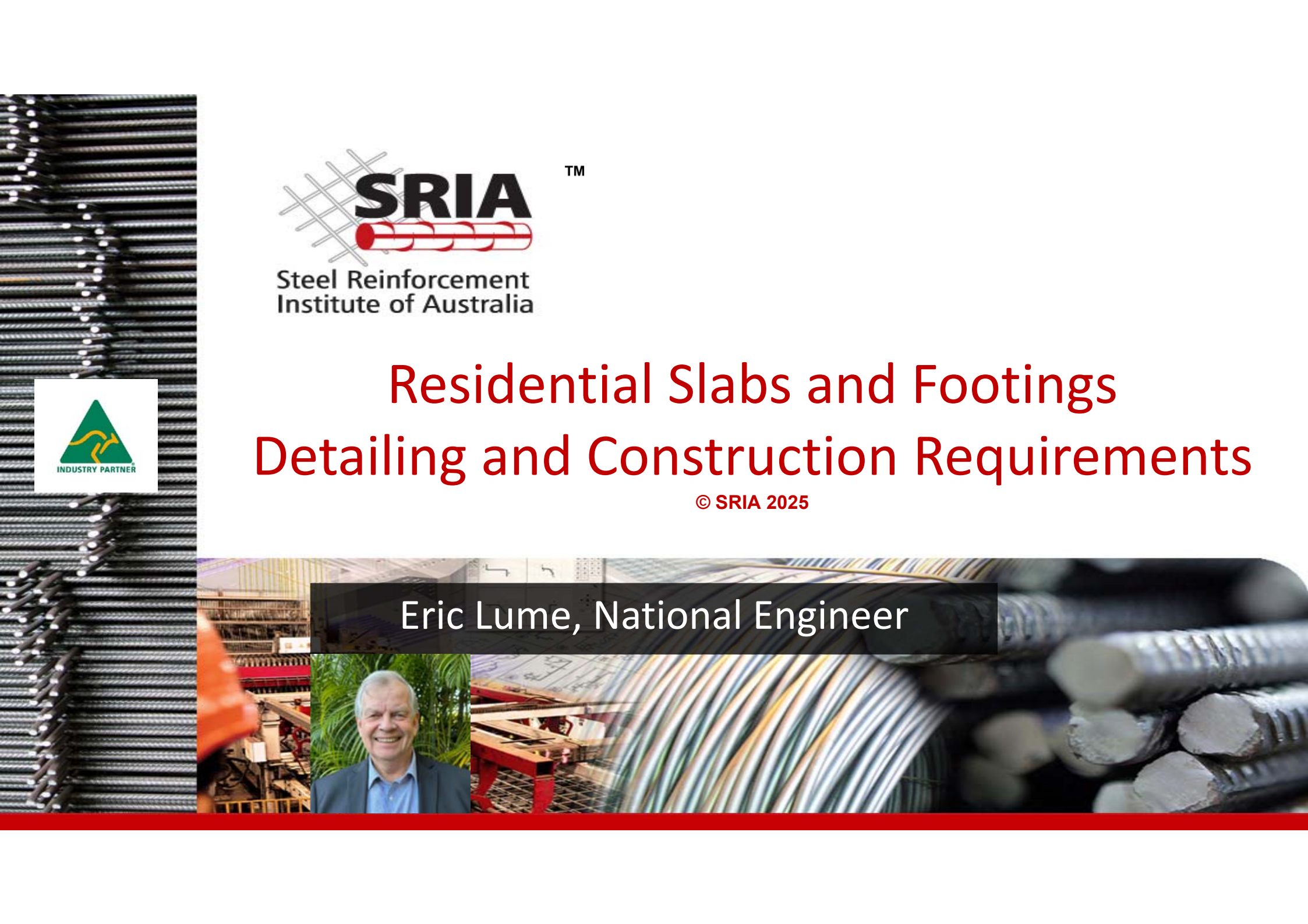
# Thank you





# Residential Slabs and Footings Detailing and Construction Requirements

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The background of the slide is a collage of images related to steel reinforcement. On the left, there are vertical stacks of rebar. On the right, there are large coils of rebar. In the center, there is a construction site with rebar being installed in a concrete slab. Overlaid on this background is a dark grey rectangular box containing the text 'Eric Lume, National Engineer'.

Eric Lume, National Engineer



## Problem or Performance

**The most controversial aspect of AS 2870 is almost certainly that some damage may occur even though all parties have fulfilled their obligations competently.**

- ➔ Some factors unknown even after detailed investigation
- ➔ Compromise between cost and reasonably foreseeable actions
- ➔ Standard designs not expected to fully resist all actions
- ➔ Homeowners may request more conservative design

### Clause 1.4.3

The design of footing systems shall consider the following:

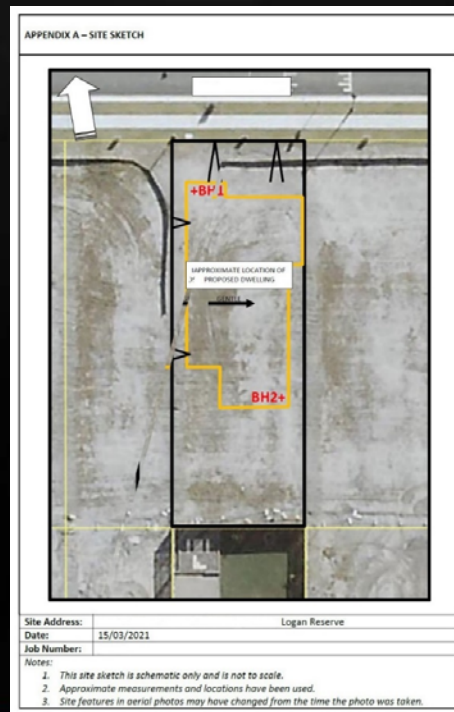
- (a) Effective drainage of the site
- (c) **Control, but not prevention, of shrinkage cracking**
- (d) **Control, but not prevention, of cracking due to footing movement**
- (e) Stiffness and ductility of the footing system
- (g) Tolerance of the wall system to movement

**Comply with AS 2870 and NCC wherever possible**

# Performance – Site Investigation

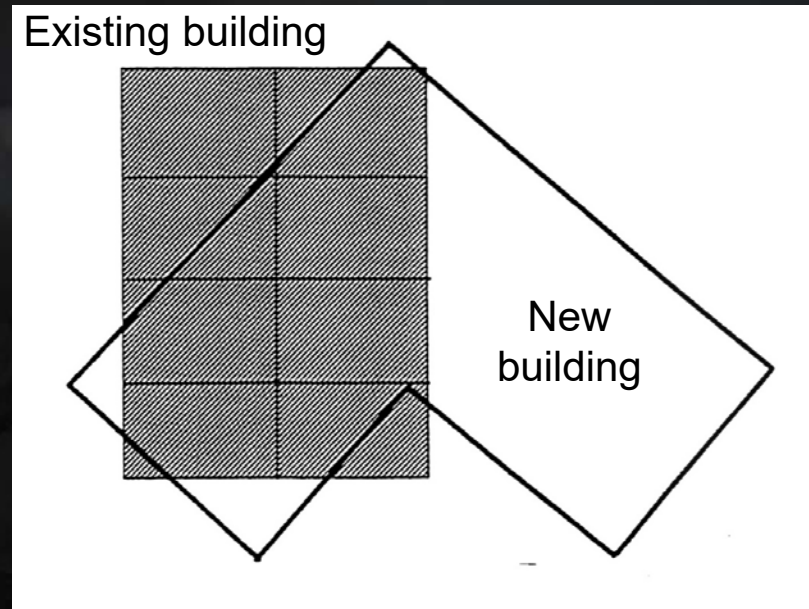
## Number of boreholes required

- ➔ Minimum one borehole or pit per building site, or site of extension
- ➔ Minimum three boreholes per site if soil known to be highly variable, or  $H_s \geq 3.0$  m
- ➔ Number across housing subdivision may be reduced if consistent



# Abnormal Moisture Conditions

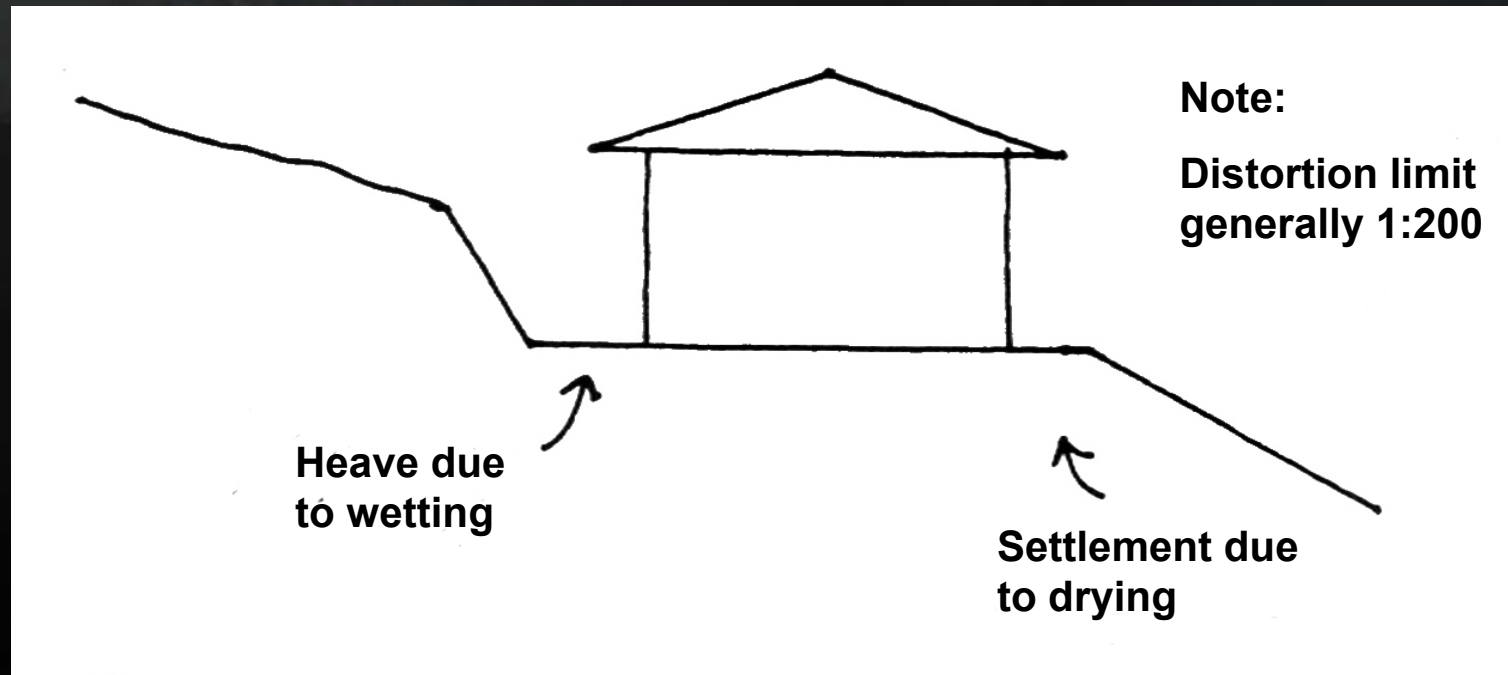
- ➔ Drains
- ➔ Channels
- ➔ Ponds
- ➔ Dams
- ➔ Tanks
- ➔ Trees
- ➔ Fill
- ➔ Urbanisation
- ➔ Previous structures
- ➔ Onsite wastewater disposal

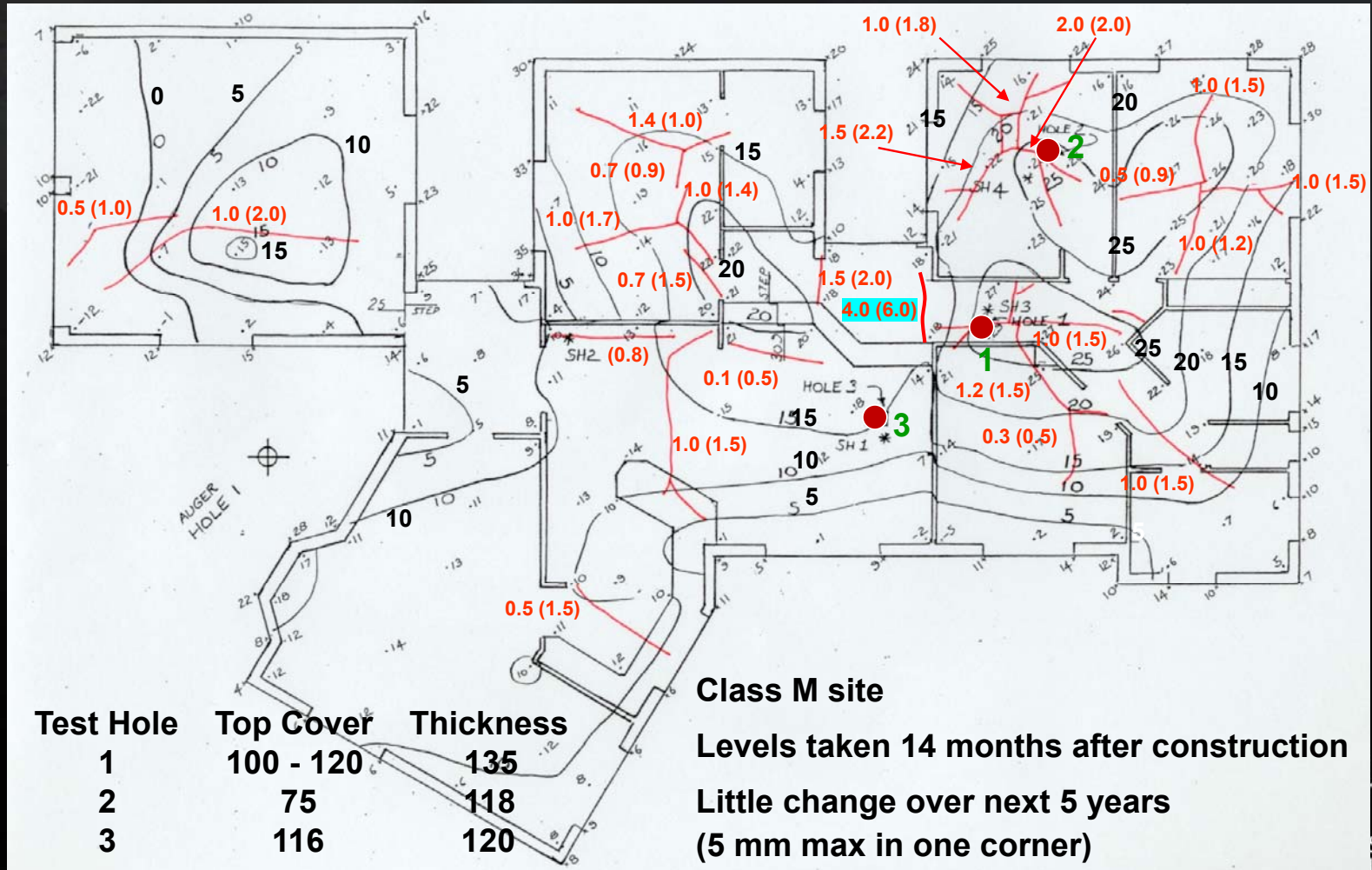


Previous structure may have changed moisture conditions

# Abnormal Moisture Conditions

## Cut and fill





## Table C2 of AS 2870

### Classification of Damage with reference to concrete floors (extract)

Note: Occasional incidence of damage category 2 is expected (Cl 1.3.1)

| Description of typical damage                                                                                    | Approx. crack width limit in floor | Change in offset from a 3 m straightedge centred over defect | Damage category  |
|------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------------------|------------------|
| Hairline cracks, insignificant movement of slab from level<br>(Usually no damage – Clause 1.3.1)                 | < 0.3 mm                           | < 8 mm                                                       | 0<br>Negligible  |
| Fine but noticeable cracks. Slab reasonably level<br>(Low incidence of damage category 1)                        | < 1.0 mm                           | < 10 mm                                                      | 1<br>Very slight |
| Cracks noticeable but easily filled.<br>Doors and windows stick slightly<br>(Occasional incidence of Category 2) | < 2.0 mm                           | < 15 mm                                                      | 2<br>Slight      |

➔ How to ensure limits are achieved?

➔ Construct in accordance with Standard

# Construction in accordance with AS 2870?

**Not just about placing concrete**

**All factors must be considered as contributing to performance**

- ➔ Classify site correctly
- ➔ Select appropriate standard design
- ➔ Modify if necessary for site conditions eg rock outcrops, pipes
- ➔ Comply with detailing requirements
- ➔ Comply with construction requirements
- ➔ Unless all requirements satisfied – **PERFORMANCE SOLUTION**

# Construction in accordance with AS 2870?

**Not just about footing/raft design**

**Walling must also be considered**

## **Articulated Masonry**

Section 3 Standard Designs include details for:

- ➔ Articulated masonry veneer
- ➔ Articulated full masonry

### **Clause 1.8.1 Articulated full masonry**

Full masonry construction incorporating articulation of external and internal walls

### **Clause 1.8.2 Articulated masonry veneer**

Masonry veneer construction incorporating articulation of the masonry veneer.

# Articulated Masonry

## Typical articulation joints



# Articulated Masonry

## AS 4773.1 (2015)

### Masonry for small buildings

- ➔ contains requirements for articulation joints
- ➔ called up in NCC (BCA)
- ➔ contraction joints included
- ➔ expansion joints included

### Also refer to:

CCAA TN61

Articulated Walling

[www.ccaa.com.au](http://www.ccaa.com.au)

Referenced in AS 2870

TABLE 13.1

SPACING OF ARTICULATION JOINTS FOR  
UNREINFORCED MASONRY WALLS

| Site class<br>(see Note) | Masonry wall construction<br>and surface finish | Joint spacing, m                   |                                       |                                       |
|--------------------------|-------------------------------------------------|------------------------------------|---------------------------------------|---------------------------------------|
|                          |                                                 | Up to 4 m high<br>for 10 mm joints | 4 m to 8.5 m high<br>for 10 mm joints | 4 m to 8.5 m high<br>for 15 mm joints |
| M, M-D                   | External face finish masonry                    | 6.0                                | 4.2                                   | 6.0                                   |
|                          | External rendered and/or<br>painted masonry     | 5.5                                | 3.9                                   | 5.5                                   |
|                          | Internal face finish or sheeted<br>masonry      | 6.0                                | 4.2                                   | 6.0                                   |
|                          | Internal rendered and/or<br>painted masonry     | 5.5                                | 3.9                                   | 5.5                                   |
| H1, H1-D                 | External face finished masonry                  | 5.5                                | 3.9                                   | 5.5                                   |
|                          | External rendered and/or<br>painted masonry     | 5.0                                | 3.5                                   | 5.0                                   |
|                          | Internal face finish or sheeted<br>masonry      | 5.5                                | 3.9                                   | 5.5                                   |
|                          | Internal rendered and/or<br>painted masonry     | 5.0                                | 3.5                                   | 5.0                                   |
| H2, H2-D                 | External face finished masonry                  | 5.0                                | 3.5                                   | 5.0                                   |
|                          | External rendered and/or<br>painted masonry     | 4.5                                | 3.2                                   | 4.5                                   |
|                          | Internal face finish or sheeted<br>masonry      | 5.0                                | 3.5                                   | 5.0                                   |
|                          | Internal rendered and/or<br>painted masonry     | 4.5                                | 3.2                                   | 4.5                                   |

NOTE: Site class as defined in AS 2870. For further information and guidance on site classification, see AS 2870.

# Section 5 Detailing Requirements

## Drainage

### Requirements for rafts and slabs

- ➔ Concrete
- ➔ Reinforcement
- ➔ Vapour barriers and damp-proofing membranes
- ➔ Edge rebates
- ➔ Recesses in slab panels
- ➔ Heating cables and pipes
- ➔ Shrinkage cracking control
- ➔ Beam continuity in rafts
- ➔ Beam layout restrictions

# Section 5 Detailing Requirements

## Requirements for Pad and Strip Footings

- ➔ Concrete
- ➔ Reinforcement
- ➔ Stepping of strip footings

## Requirements in Aggressive Soils

## Additional requirements for Classes M, H1, H2 and E Sites

# Drainage

## Avoid water ponding against or near the footing

- ➔ Slope ground away from building (50 mm over 1 m width)
- ➔ Consider effects of a number of variables such as flooding and landscaping

## Avoid water entering the building

For Class 1 buildings, minimum floor height above finished ground or paving level

- ➔ 150 mm typically
- ➔ 100 mm for sandy, well-drained areas
- ➔ 50 mm where adjacent paving slopes away from building
- ➔ May be reduced locally (at doorways) if shielded from weather  
(mandatory requirement for level access)

# Vapour Barriers & Damp-proofing Membranes

## Materials, properties and installation

- ➔ only in AS 2870 (Clause 5.3.3)

## NSW and SA

- ➔ required to have damp-proofing membrane

## Damp-proofing membranes

- ➔ Film thickness – 0.2 mm
- ➔ High impact resistance – Falling Dart Test
- ➔ Resistance to puncture and moisture penetration – CSIRO Test

# Damp-proofing Membranes

## To ensure products meet requirements of NCC

- ➔ Obtain evidence of conformity and compliance
- ➔ Builders and inspectors should check that material supplied and installed is what has been specified in the plans and specifications
- ➔ Check that product is continuously branded as required by NCC
- ➔ Refer Advisory Notice Building 01/20  
Department for Infrastructure and Transport, SA

### **ADVISORY NOTICE** 01/20 **BUILDING**

Advisory Notices are issued to assist in the interpretation of the Planning, Development and Infrastructure Act 2016 and the Development Act 1993

April 2020

#### **TECHNICAL:**

#### **DAMP-PROOFING MEMBRANE REQUIREMENTS IN SOUTH AUSTRALIA**

The purpose of this Notice is to provide information about the damp-proofing membrane requirements that apply in South Australia, the importance of these membranes complying/conforming with the requirements, and the responsibilities of the parties involved in their manufacture, supply and installation.

This Notice will also address concerns raised by the construction sector about an increasing number of non-compliant and non-con-forming products.

#### **The importance of damp-proofing membranes**

Buildings in South Australia are prone to rising damp and salt attack if they are not adequately protected from moisture rising from the soil below. Protection against such damage is provided through the installation of a damp proofing membranes (DPM), referred to as a vapour barrier in some States and Territories, which are laid on the ground under the concrete slab prior to the slab being poured. **Diagram A** indicates the location of the DPM in a typical slab-on-ground house. Similar products, referred to as damp-proof courses (DPCs) are also installed in walls to prevent moisture rising, however this Notice does not discuss DPCs.

If the damp-proofing products are absent or faulty, moisture can rise through the concrete slab and may have a serious, detrimental effect on the health of the occupants. As the slab becomes heavily loaded with moisture, the damp lower areas of the building can become populated with bacteria. Mould and other micro-organisms flourish in these environments and can cause allergies, asthma and irritation of the throat, eyes and skin.

A faulty DPM can allow moisture to migrate from underneath the concrete slab or from the edge of the slab into the building. If the dampness breaches the DPC in the walls it may also destroy brick work, mortar joints, internal timber walls and footings. Often the first sign of a problem is damp patches on internal carpet or cupped, warped and twisted flooring or floor boards. This is often referred to as slab edge dampness (**Picture A**).

## Slab Edge Dampness - Indicators

- ➔ Persistent dampness of the exposed face
- ➔ Pungent odours in floor coverings
- ➔ Watermark stains on walls
- ➔ Mould growth
- ➔ External paint blistering/peeling below the DPC
- ➔ Delaminating (drummy) render below the DPC



(courtesy New Home Inspections, Melbourne)



(courtesy Visual Landscaping, Adelaide)



(courtesy Visual Landscaping, Adelaide)

# Slab Edge Dampness

## Some Resources

1. CCAA Data Sheet - Slab Edge Dampness and Moisture Ingress
2. CIA – Slab Edge Dampness

**DATAsheet** >

JAN 2005

### SLAB EDGE DAMPNESS and Moisture Ingress

**GENERAL**  
The majority of houses incorporating well-constructed and well-detailed concrete slabs and footings experience no problems with slab edge dampness. Where problems do occur, there may be one or more of several causes. A thorough investigation is required to determine the most appropriate course of action to rectify the problem. Most slab edges are occasionally damp due to rain, garden watering or by contact with the ground. In some cases this dampness is able to permeate from the outside to the inside and affect the internal walls and/or finishes such as the floor coverings. Preventative measures are far more effective than facing the often difficult and costly repairs required to remedy problems caused by slab edge dampness and moisture ingress. This data sheet explains why slab edge dampness occurs and provides recommendations to reduce the risk of moisture ingress and thus avoid the associated problems.

**INDICATIONS OF SLAB EDGE DAMPNESS**  
The initial indication of a problem is usually persistent dampness of the exposed face of the concrete slab/footing, often resulting in associated efflorescence (a build up of a white coloured powdery substance below the damp-proof course (DPC)). It may also result in the development of:

- pungent odours in floor coverings ie damp carpets;
- watermark stains on wall linings and/or joinery;
- mould growth;
- rusting, surface corrosion or oxidation of metal near or adjacent to the edge of the slab/footing;
- loss of bond of adjacent wall and floor ties;
- external paint blistering/peeling below the DPC;
- delaminating (drumming) render below the DPC.

↓

THE INITIAL INDICATION of a problem is usually persistent dampness of the exposed face of the concrete slab/footing.

**CEMENT CONCRETE & AGGREGATES AUSTRALIA**

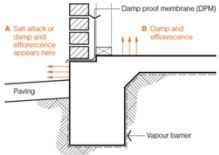
Leading Knowledge • Sharing Information

Current Practice Note 30

**CONCRETE INSTITUTE of AUSTRALIA**

### Slab Edge Dampness

**THE PHENOMENON**  
Slab edge dampness is a condition related to the serviceability of a concrete raft footing. The major visible symptom of this condition is areas of dampness (sometimes with efflorescence) on the slab floor internally, adjacent the perimeter walls and on the exposed edge of the footing, externally. In areas with saline soils or where saline subfloor fills have been used efflorescence and 'salt attack' of the concrete surfaces usually follows. In South Australia the term 'salt damp' is used to describe what is broadly referred to as salt attack. Salt attack is the physical exfoliation of a concrete or masonry surface caused by pressure exerted in surface pore spaces derived from crystalline salt growth and any phase change of salts from their anhydrous state to their hydrated state. Some of the salts found in soils are sulphates, chlorides, nitrates, and carbonates of sodium, calcium, magnesium and potassium. Symptoms first reported by builders and owners inside buildings are damp areas under carpets or vinyl floor coverings, with efflorescence and damp slab surfaces. In more severe cases flaking or crumbling of the concrete surface has also been reported. The external exposed edge of the footing often exhibits efflorescence or a 'salt attack' type deterioration of the exposed concrete surface. Figure 1 shows the areas commonly affected by a slab edge dampness condition.



**Figure 1 Note:** (A) will usually occur (if top of paving is more than around 50 mm from top of edge footing beam). (B) will usually occur (if top of paving is around 50 mm or less from top of edge footing beam). (A) and (B) may occur together when top of paving is less than around 50 mm from top of edge footing.

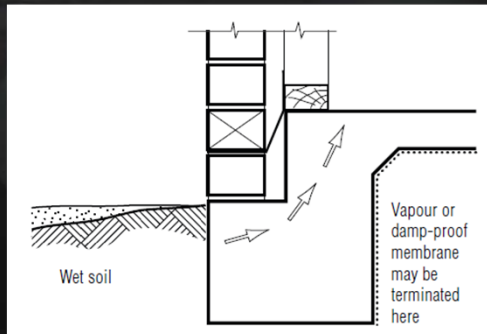
**SCOPE**  
This practice note explains the possible conditions which may cause, or contribute to, slab edge dampness. The factors which are attributed to edge dampness problems may vary in significance from one site to another and they may also vary around an individual site. It is not necessary for all the contributing factors to be present for slab edge dampness to occur as any one factor may cause the condition. Furthermore, one factor may not be the cause of the problem for the whole of the building. A thorough investigation of an affected property is necessary to isolate the possible cause, or causes, of slab edge dampness. The rectification of this condition can be costly as it is usually reported after occupancy and the completion of perimeter paving. However, with sound building practice and good site supervision the occurrence of slab edge dampness can, at little cost, be dramatically reduced or eliminated.

ISBN 0 909775 51 8  
October 1998 CPN 30

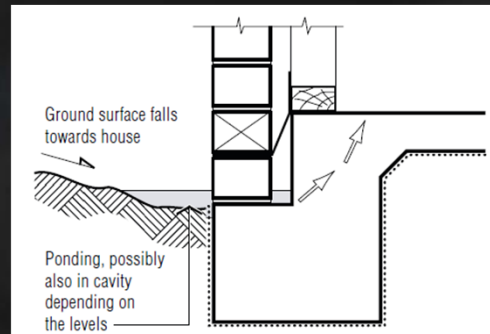
**SRIA**  
Steel Reinforcement Institute of Australia

# Slab Edge Dampness Causes and Solutions

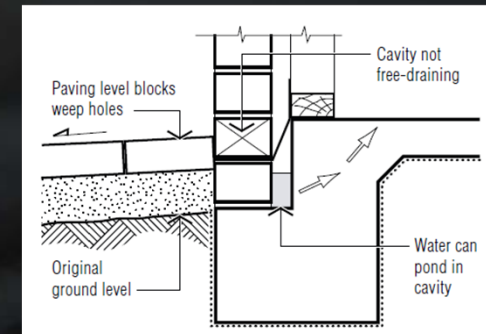
## Not Recommended



Slab edge in direct contact with ground

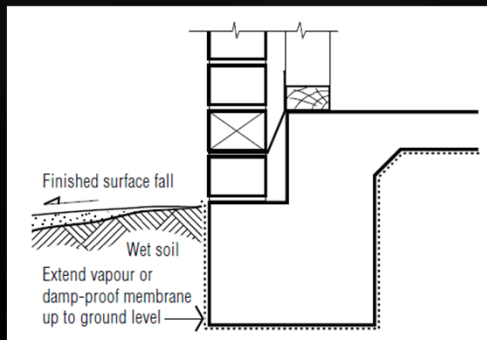


Inadequate drainage

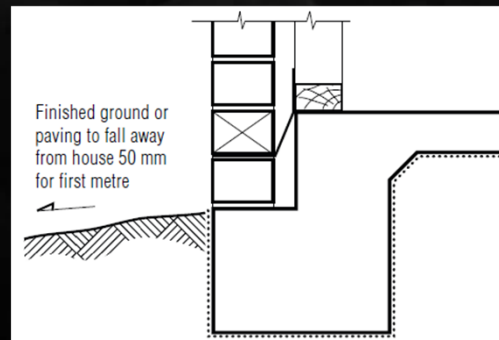


Inadequate cavity drainage

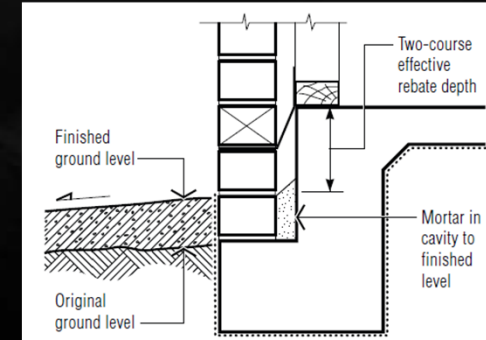
## Recommended



Extend vapour barrier to ground level



Free draining cavity and surrounds

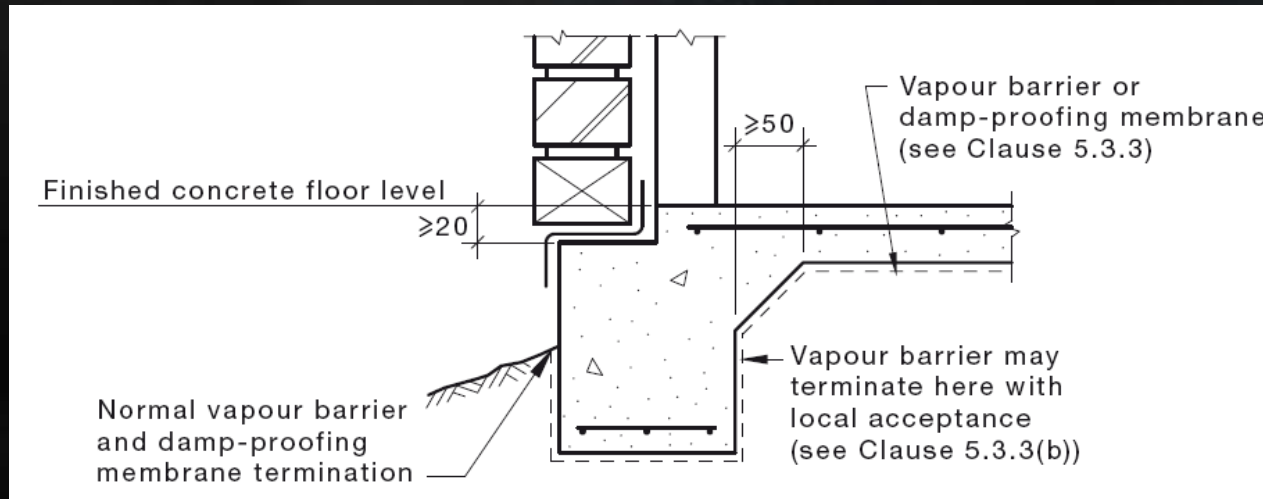


Mortar filled cavity to finished ground level

Images from CCAA Data Sheet

## Edge Rebates

- ➔ Minimum depth of 20 mm, except for single-leaf masonry
- ➔ Requirements for depths  $> 150$  mm
- ➔ Where retaining  $> 450$ mm of fill – refer Clause 6.4.5



Minimum rebate for cavity masonry or veneer wall

(Figure 5.2(a) from AS 2870 - 2011)

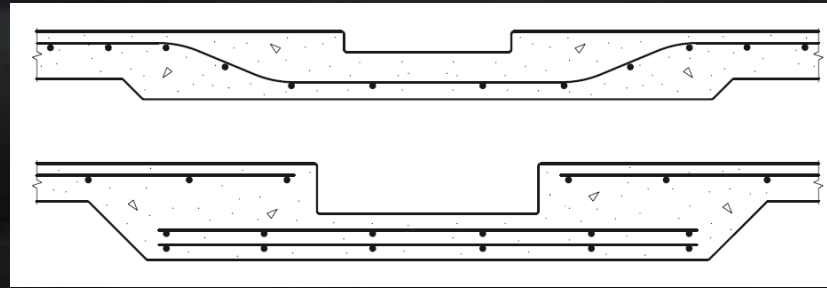
# Requirements for Rafts and Slabs

## Recesses in slab panels

- ➔ Required slab thickness to be maintained
- ➔ Continuity of reinforcement to be maintained

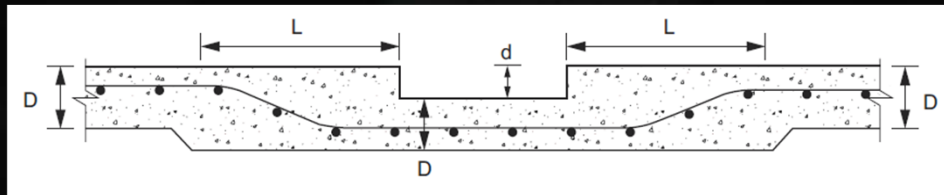
Slab detail at a recess

(Figure 5.3 from AS 2870 - 2011)

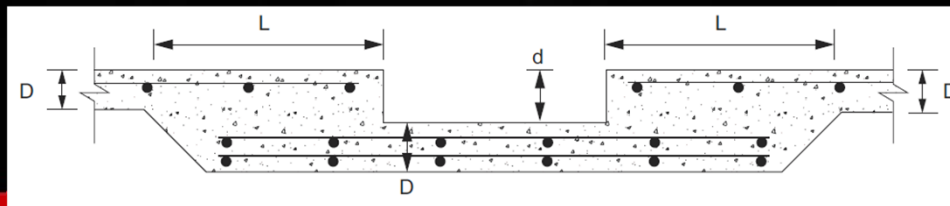


## Section 4.2.22 of NCC Housing Provisions Standard

Recess depths ( $d$ ) less than or equal to nominal slab thickness



Recess depths ( $d$ ) greater than nominal slab thickness



# Requirements for Rafts and Slabs

## Shrinkage cracking control

- ➔ Re-entrant corners – 2 x 3-L8TM, 1 x 3-L11TM or 3-N12
- ➔ Brittle floor coverings
  - ➔ Minimum SL92 mesh or extra layer of slab mesh
  - ➔ Use appropriate bedding system
  - ➔ Delay placement of brittle finishes



Large tiled areas



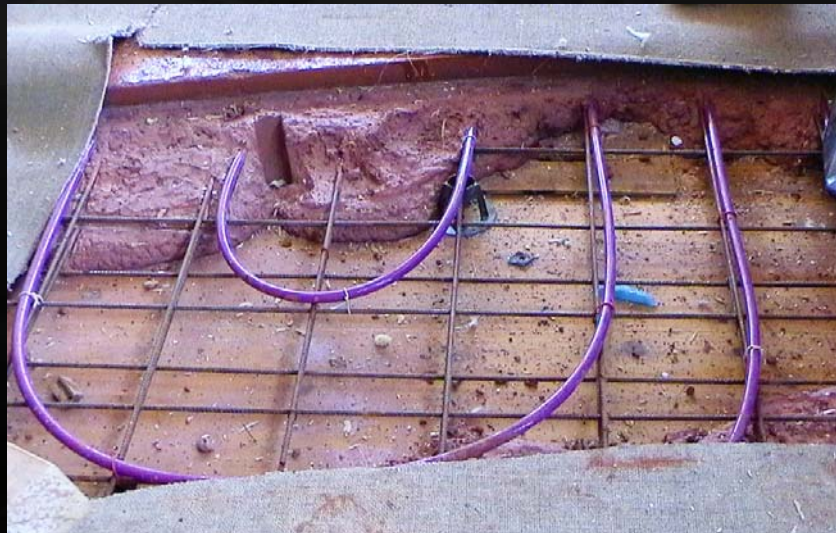
Polished concrete

# Requirements for Rafts and Slabs

## Shrinkage cracking control – floor heating

- ➔ Electric systems – no increase in slab thickness or mesh size
- ➔ Hydronic systems
  - ➔ increase slab thickness by 25 mm
  - ➔ increase mesh by one size

Hydronic floor heating system



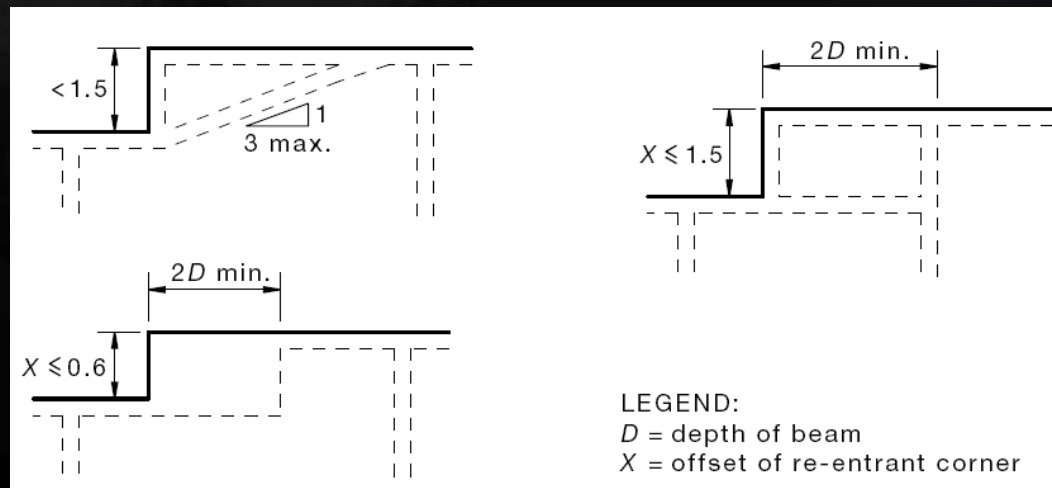
# Requirements for Rafts and Slabs

## Beam continuity in rafts

Continuity of internal and external beams must be maintained

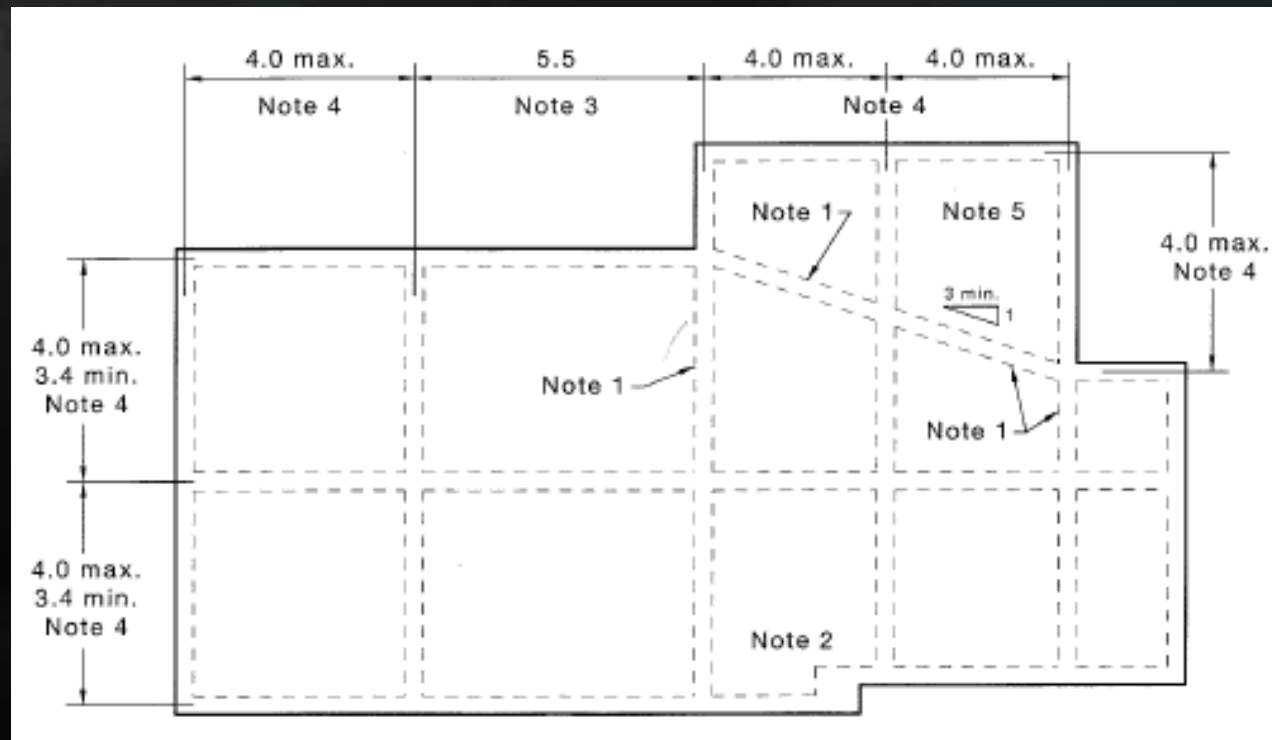
- ➔ from edge to edge of the slab
- ➔ across steps in the slab (Clause 6.4.4 (c) (iii))
- ➔ at re-entrant corners
  - ➔ provide internal beam
  - ➔ if  $< 1.5$  m, refer details in Figure 5.4

Continuity of footing beams  
(Figure 5.4 from AS 2870 - 2011)  
(dimensions in metres)



# Requirements for Rafts and Slabs

## Beam continuity in rafts - Commentary



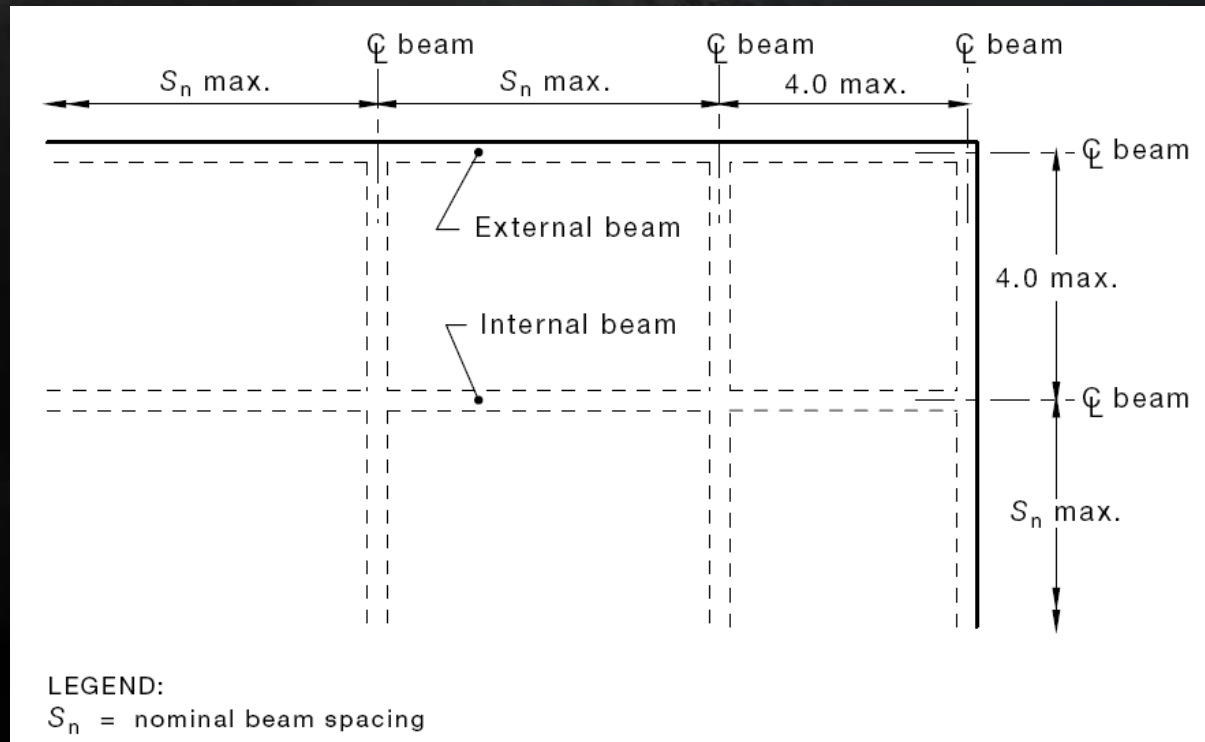
Arrangement of stiffening beams  
(Figure C5.4 from AS 2870 - 2011)

# Requirements for rafts and slabs

## Beam layout restrictions

Limits placed on spacing of internal beams at external corners

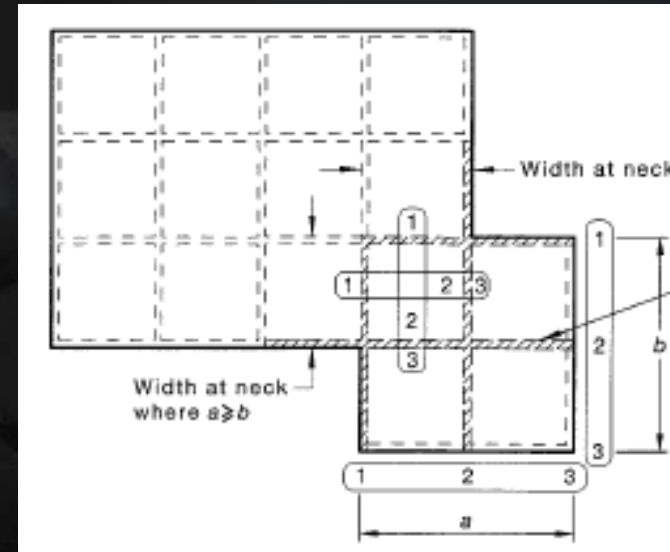
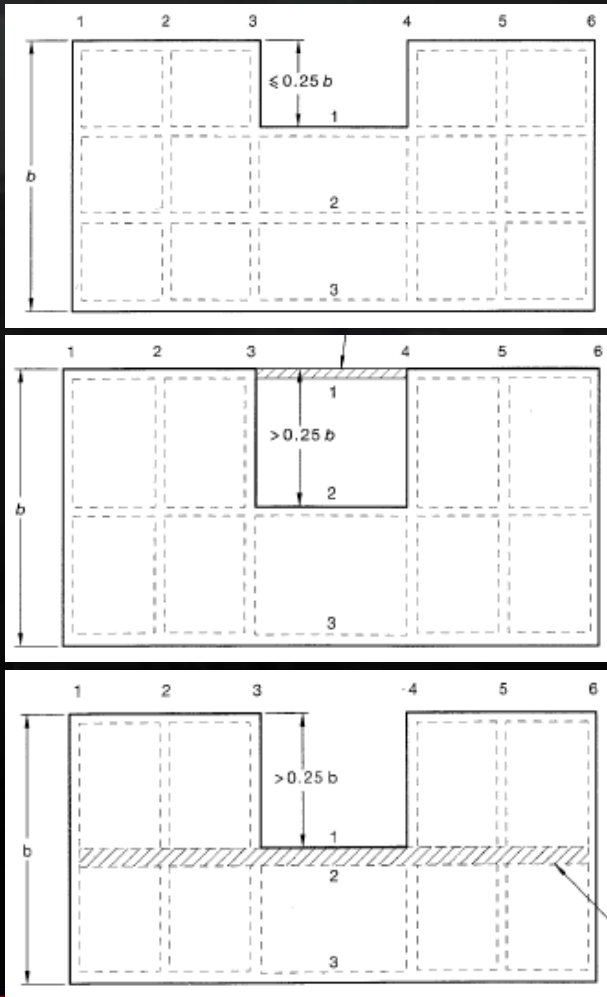
➔ Controls deflection at external corner



Beam spacing at external corners (Figure 5.5 from AS 2870 - 2011)

# Requirements for Rafts and Slabs

## Beam continuity in rafts – maintain stiffness



Arrangement of stiffening beams  
(Figure C5.5 from AS 2870 - 2011)

# Requirements for Rafts and Slabs

## Beam continuity in rafts – maintain stiffness

Some beams not continuous



Continue internal beam

Internal beam max. 4 m from corners?



Provide additional internal beams

# Requirements for Rafts and Slabs

## Beam continuity in rafts – maintain stiffness

Continue edge beam  
to next internal beam

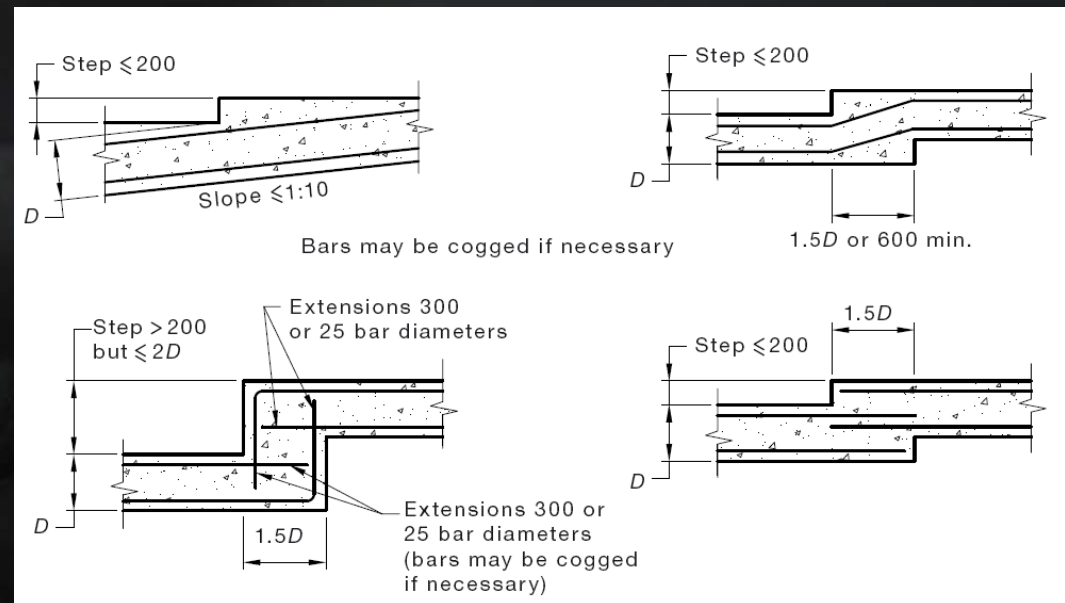


# Requirements for Pad and Strip Footings

**Concrete** – as for rafts and slabs

**Reinforcement** – covered

**Stepping of strip footings**



Acceptable methods of stepping strip footings

(Figure 5.6 from AS 2870 - 2011)

## Cover to Reo – May be Difficult to Maintain



# Requirements in Aggressive Soils

## Saline and sulphate soils



Western  
Sydney



Wagga Wagga  
NSW

Efflorescence is more  
common sign of soil salinity



Ineffective damp proof course?  
Filled above damp proof course?

# Requirements in Aggressive Soils

## Requirements in Aggressive Soils – Clause 5.5

### Two choices:

1. Isolate the concrete or masonry member from the aggressive soil
2. Use appropriate concrete strength and cover

### Isolation of Concrete

Provide damp-proofing membrane up to ground or finished paving level

- ➔ Extend membrane from under slab up to ground or paving surface
- ➔ Lap membrane from under slab with suitable damp-proofing material (0.5 mm thick) or liquid-applied waterproofing compound applied to face of concrete and extend up to finished ground or paving level



# Requirements in Aggressive Soils

Extend membrane from under slab up to finished ground or paving level

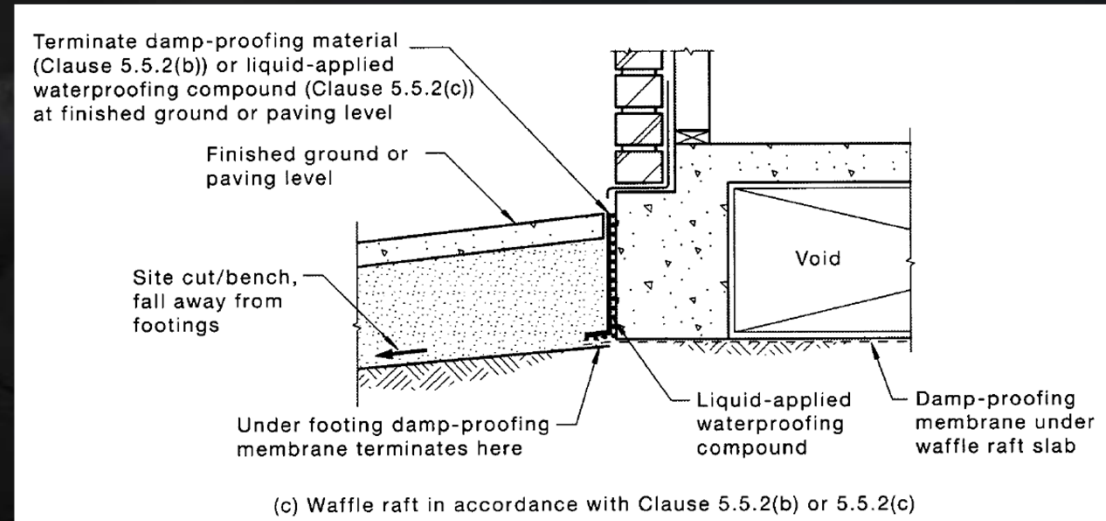
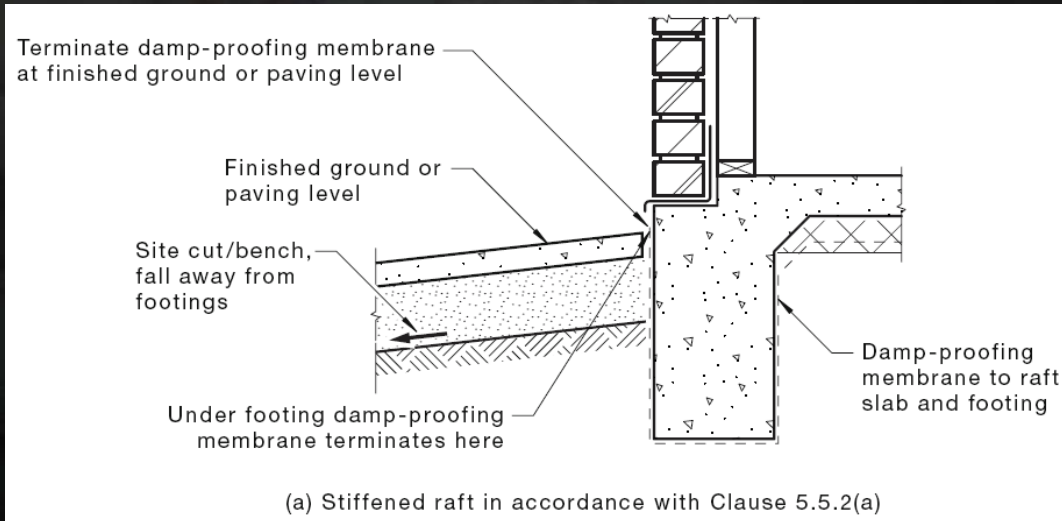


Figure 5.7 Use of damp-proofing membrane for slab protection

(from AS 2870 - 2011)

# Requirements in Aggressive Soils

Some situations may be difficult to comply or rectify

Consider alternate edge treatments to exclude aggressive agents



# Requirements in Aggressive Soils

## Appropriate concrete strength and detailing

### Step 2 Determine required concrete strength and curing

Minimum design characteristic strength (  $f'_c$  ) and curing requirements for concrete (after Table 5.3 of AS 2870 - 2011)

| Exposure classification | Minimum MPa | Minimum initial curing requirement    |
|-------------------------|-------------|---------------------------------------|
| A1                      | 20          | Cure continuously for at least 3 days |
| A2                      | 25          |                                       |
| B1                      | 32          | Cure continuously for at least 7 days |
| B2                      | 40          |                                       |
| C1                      | ≥50         |                                       |
| C2                      | ≥50         |                                       |

- ➔ Standard designs only apply to 20 and 25 MPa concrete (Clause 3.1.1 of AS 2870)
- ➔ For higher strengths, check ductility requirements

# Requirements in Aggressive Soils

## Appropriate concrete strength and detailing

### Step 3 Determine minimum reinforcement cover

Minimum reinforcement cover for concrete (after Table 5.4 of AS 2870 - 2011)

| Exposure classification | Minimum cover in saline soils<br>(mm) | Minimum cover in sulfate soils<br>(mm) |
|-------------------------|---------------------------------------|----------------------------------------|
| A1                      | No change                             | 40                                     |
| A2                      | 45                                    | 50                                     |
| B1                      | 50                                    | 60                                     |
| B2                      | 55                                    | 65                                     |
| C1                      | Not applicable to salinity            | 70                                     |
| C2                      | Not applicable to salinity            | 85                                     |

### Concrete

- ➔ N20, 100 mm slump, 20 mm maximum nominal aggregate size
- ➔ In accordance with AS 1379 – ensures quality, not final performance

# Section 6 Construction requirements

## Excavations

- ➔ If permanent, retain material or batter sides
- ➔ If temporary, ensure adequate support of footings is maintained

## Construction of slabs

- ➔ Filling – controlled and rolled
- ➔ Foundations – Natural soil of 50 kPa bearing capacity for slabs
  - Natural soil of 100 kPa bearing capacity for edge footings not tied to a footing slab
  - stepping and sloping of edge beams
  - blinding layer of sand only required for aggressive soils
- ➔ Sloping Sites – details of cut and fill
  - stepping of slabs and beams
  - requirements for piers

# Additional requirements for Class M, H1, H2 and E Sites

Masonry detailing – control joints

Variations in foundation material – part of footing on rock

Drainage requirements – avoid water ponding adjacent to or under footings

Plumbing requirements – Clause 5.6.4 (b) and 6.6 (e) (i)

- ➔ Penetrations through footings - sleeved
- ➔ Flexible joints to drains – highly and extremely reactive sites
  - ➔ commence within 1 m of the building perimeter
  - ➔ accommodate movement up to  $y_s$  in any direction
  - ➔ be set at mid-position of their range at time of installation  
ie movement range of  $0.5 y_s$  from the initial setting

# Additional requirements for Class M, H1, H2 and E Sites

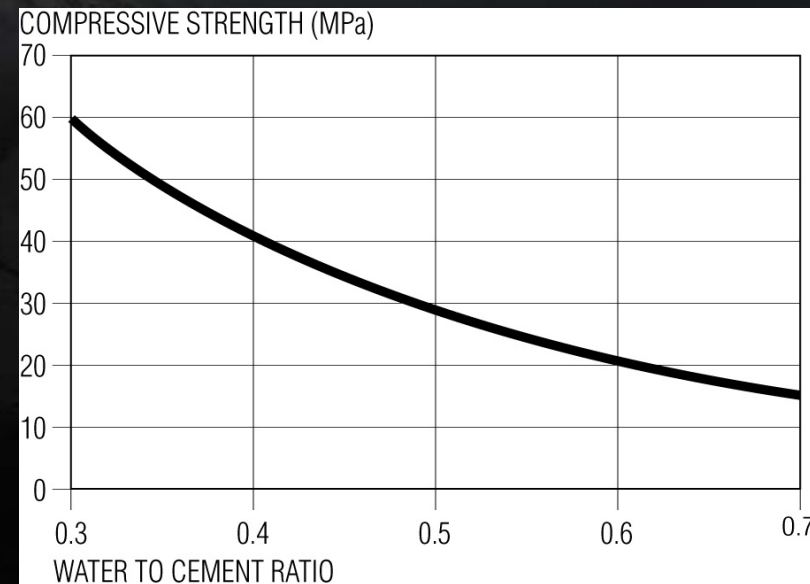
Flexible joints to drains (only when passing through footing?)



# Placing, Compaction and Curing of Concrete

Addition of excess water on-site

Should be avoided - reduces strength



w/c ratio vs strength

# Placing, Compaction and Curing of Concrete

## Addition of excess water on-site

- ➔ Produces Laitance/efflorescence
- ➔ May result in Flaking
- ➔ Increases risk of Cracking
  - both plastic and long-term drying shrinkage



Efflorescence



Flaking

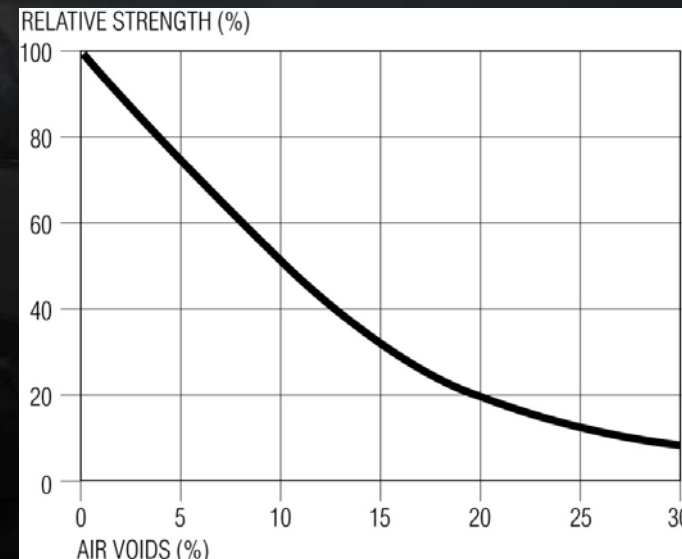


Cracking

# Placing, Compaction and Curing of Concrete

## Compaction

Expels entrapped air – improves strength and reduces risk of cracking



Loss of Strength through incomplete compaction

Adequate compaction

- ➔ Beams – mechanically vibrate
- ➔ Slabs – finishing operations satisfactory for 100 mm thickness

# Placing, Compaction and Curing of Concrete

## Compaction

Lack of compaction reduces durability and strength

Increases risk of slab edge dampness



# Placing, Compaction and Curing of Concrete

## Curing

- ➔ Application of water to or retention of water in concrete
- ➔ Improves strength
- ➔ Reduces permeability
- ➔ Reduces risk of cracking and crack widths



Add water to concrete  
(must be continuous)



Retain water in concrete



# Placing, Compaction and Curing of Concrete

## Curing

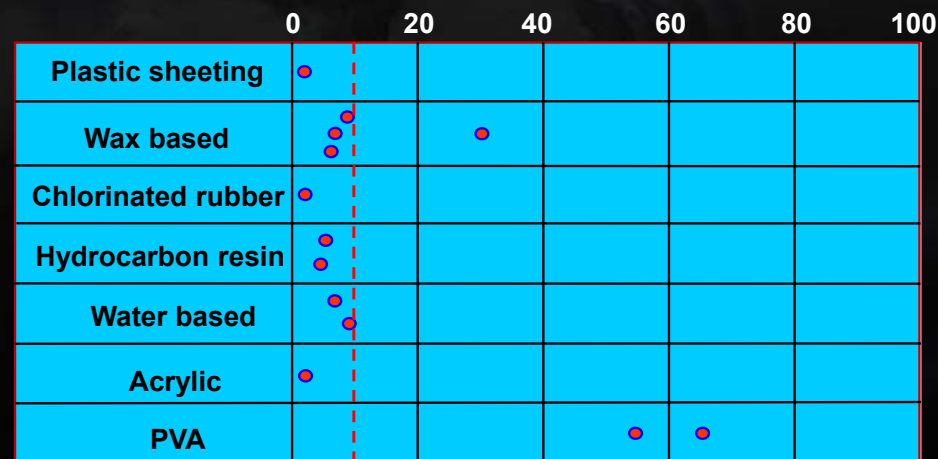
- ➔ Important for aggressive soils

Table 5.3 Curing requirements specified

Clause 5.5.3(d) Curing methods detailed

- ➔ Curing compounds to comply with AS 3799

72 Hour Moisture  
Loss (as % of  
untreated sample)

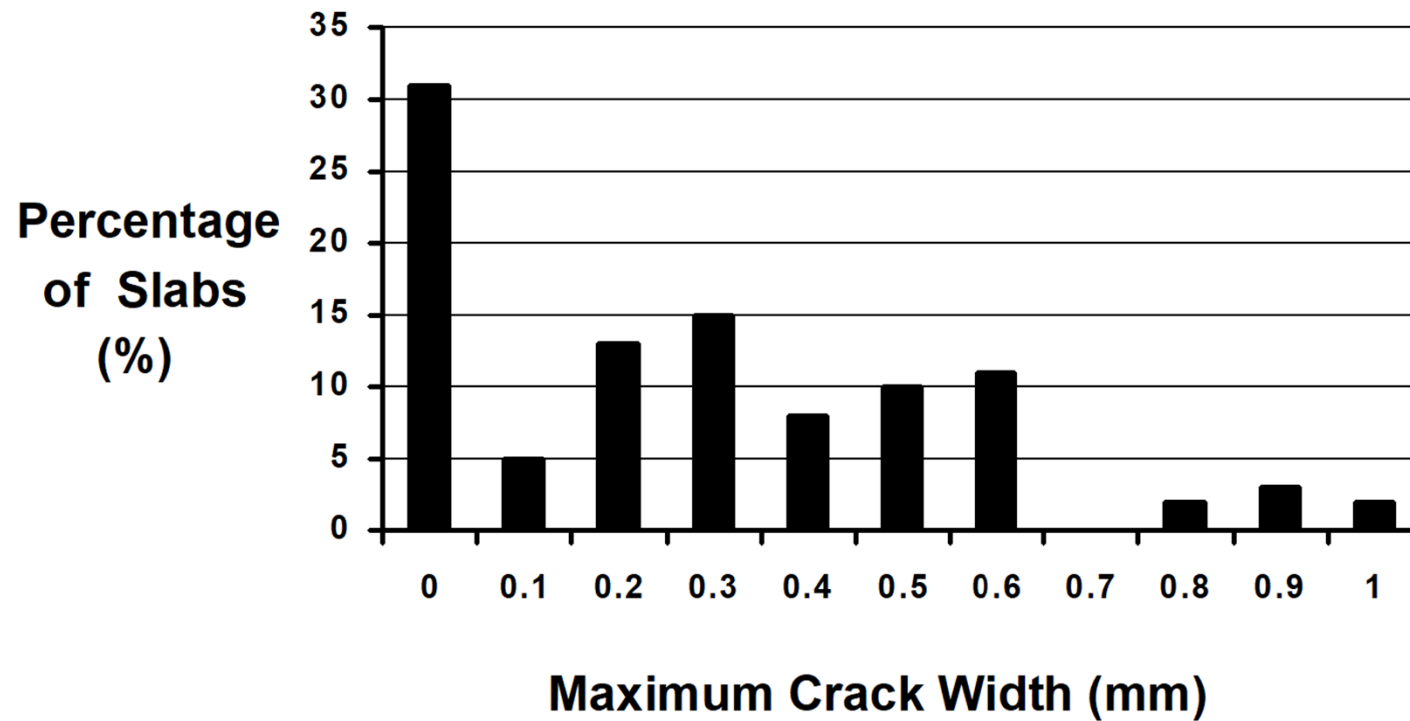


AS 3799 limit  
(90% retention)

# Crack Widths in residential Slabs

Cement and Concrete Association of Australia

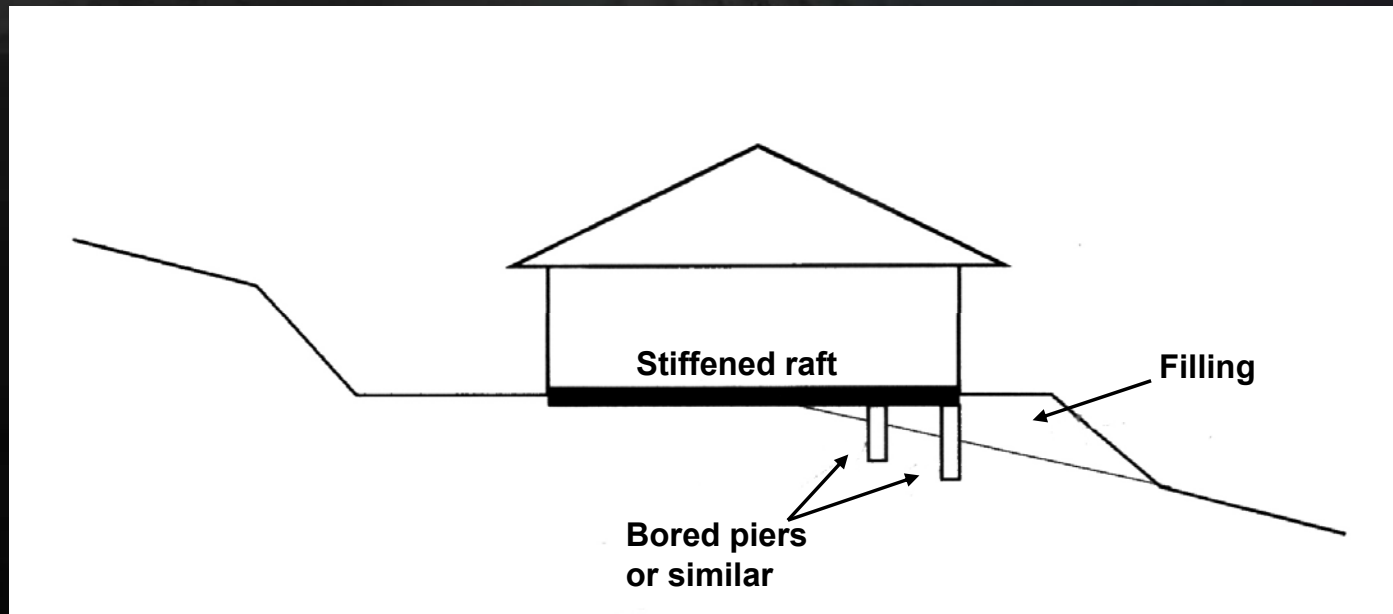
Technical Report TR/F129 (December 1996)



# Combined Footing Systems

**Is mixed construction allowed?** eg deepened footings and stiffened raft

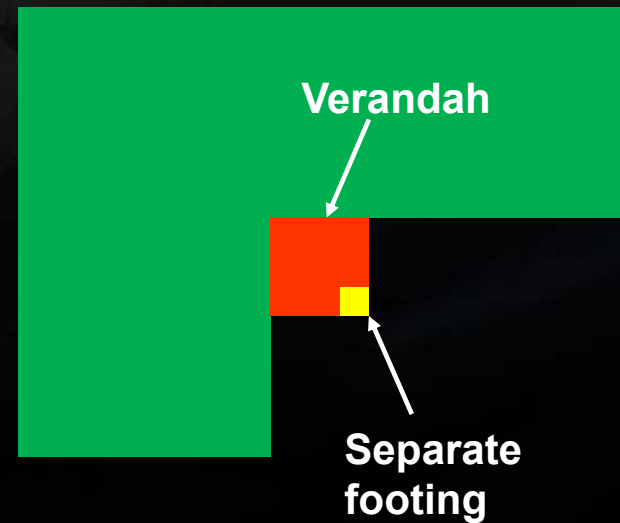
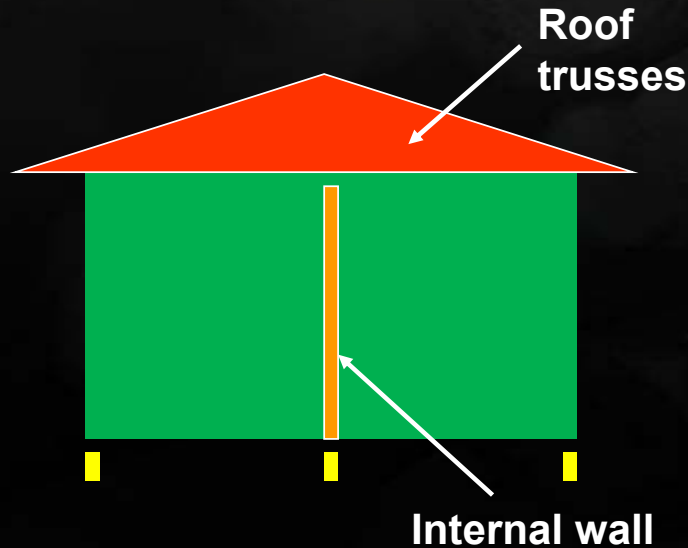
For Class M and H sites, only one standard design shall be used (Clause 3.1.1)



# Detailing Issues

## Site considerations

- ➔ Verandahs
- ➔ Trussed roofs
- ➔ Maintenance of drainage
- ➔ Gardens and watering
- ➔ Plumbing leaks



# SRIA Disclaimer

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# Thank you

