

Current Trends in Post-tensioned Building Design

Ed Cross

BE, GradDipMgt, MIEAust, CPEng

NSW Manager, Building
Austress Freyssinet

Introduction

- Design Software
- Drafting software
 - BOQ preparation
 - Automatic shop drawing generation
 - Extension calculations
- Structural solutions
 - Precast hybrid
 - Formwork solutions

The Use of Metal Deck Formwork

- Type of structural system
 - One way / Two way
- Strength design
- Long term deflections
- Fire rating
- Structural detailing
 - Connections to conventionally formed sections
 - Details at the joints
 - Nominating the system on the drawings

The Use of Metal Deck Formwork



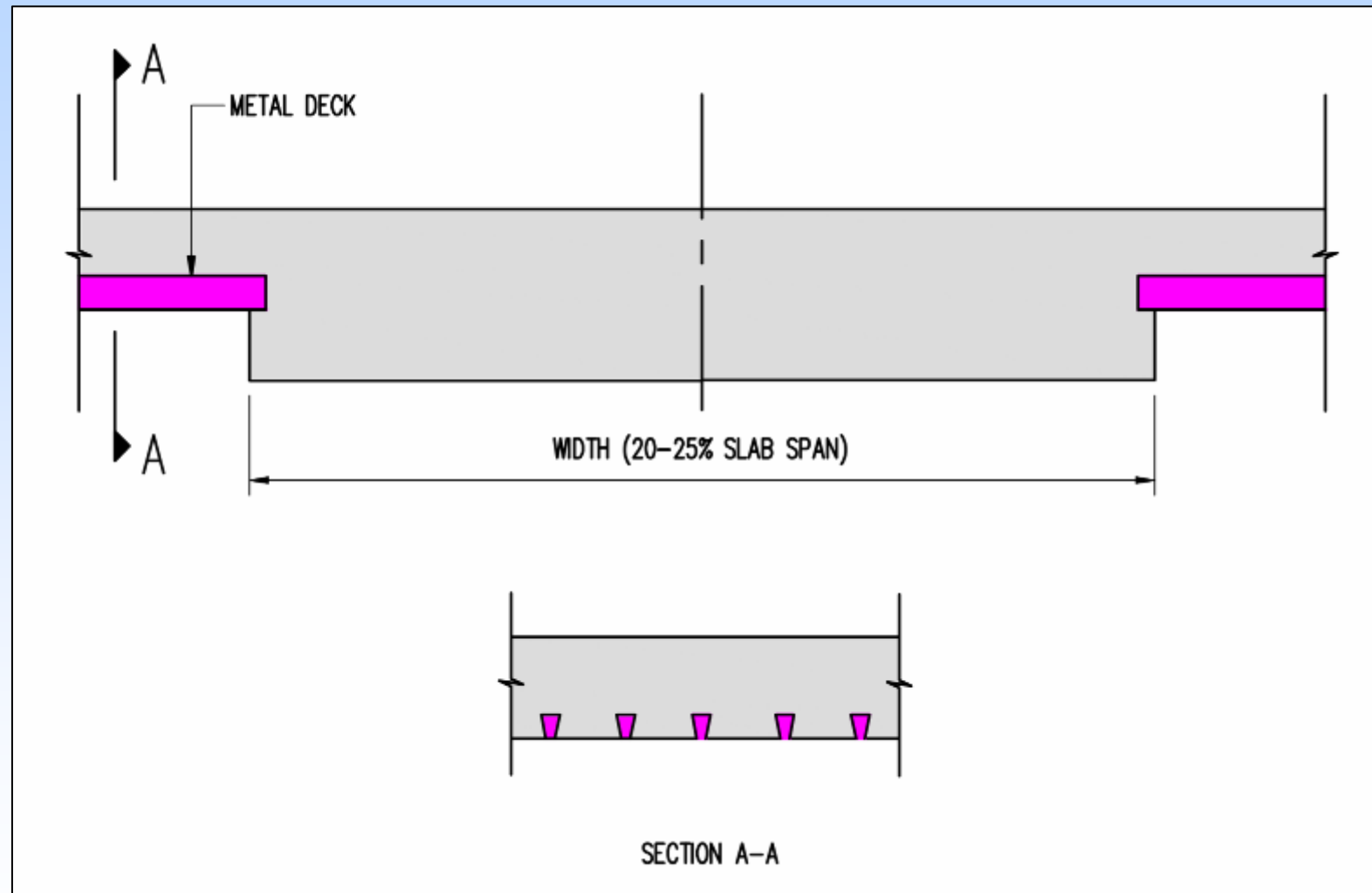
Westfield Bondi Junction

The Use of Metal Deck Formwork



Slab soffit

The Use of Metal Deck Formwork

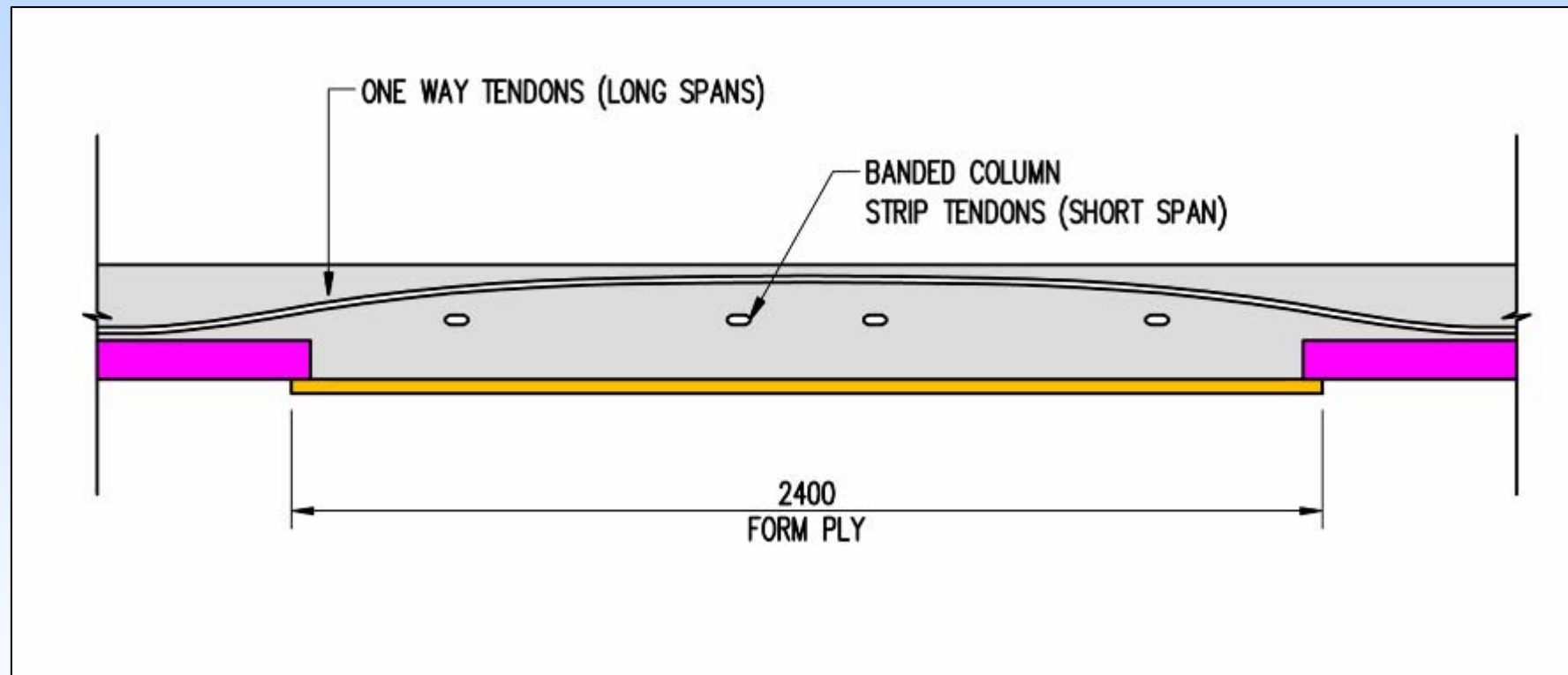


The Use of Metal Deck Formwork



P-T tendon between ribs

The Use of Metal Deck Formwork



Hybrid flat plate scheme

The Use of Metal Deck Formwork

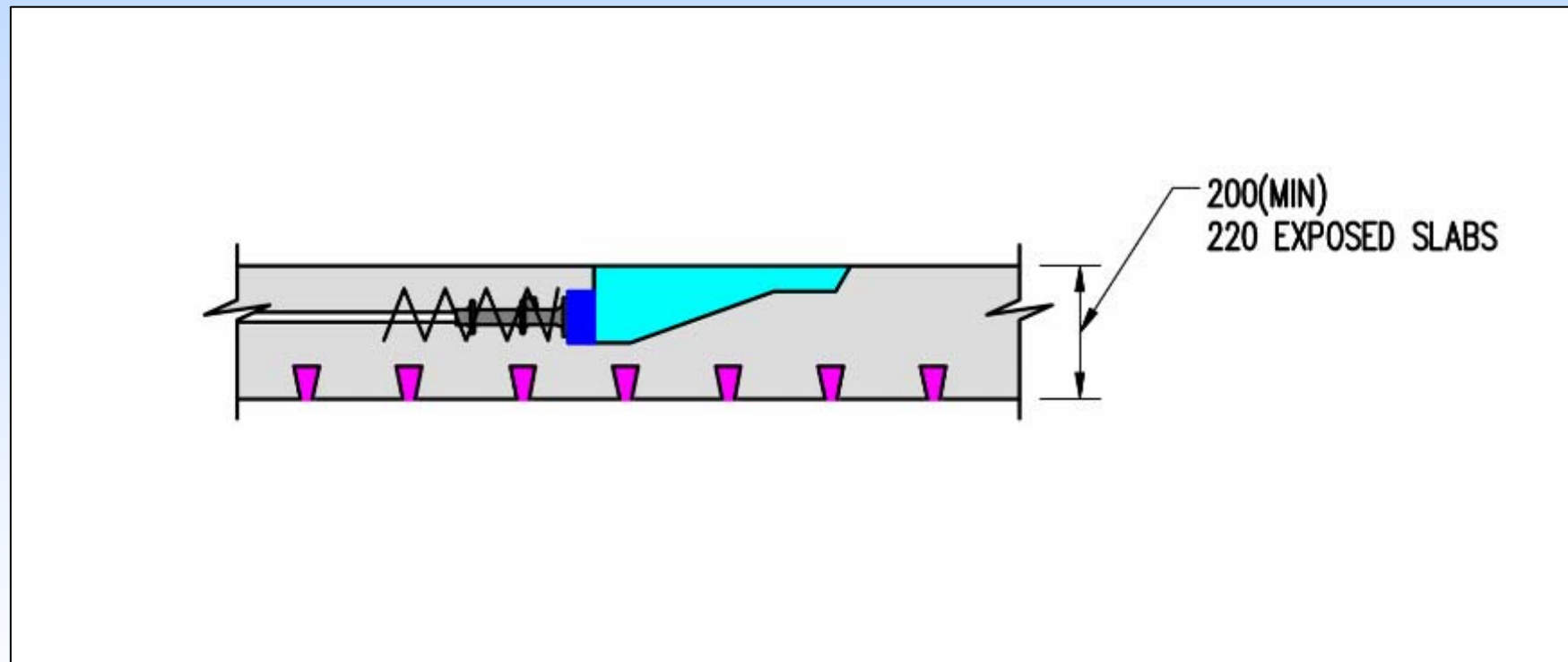
- Strength
 - Negative bending moments are generally higher
 - Do P-T slabs need bottom reinforcement?
 - Removing P-T will increase deflections
- Serviceability
 - Metal deck restrains bottom surface
 - Increased shrinkage warping deflection

The Use of Metal Deck Formwork

- Concentrated loads
 - Reduced stiffness in the 2ndy direction
 - Check width of slab able to support loads
- Fire Rating
 - Common systems satisfactory for 2 – 3 hour FRR
 - Ribbed paneled systems need checking with manufacturer

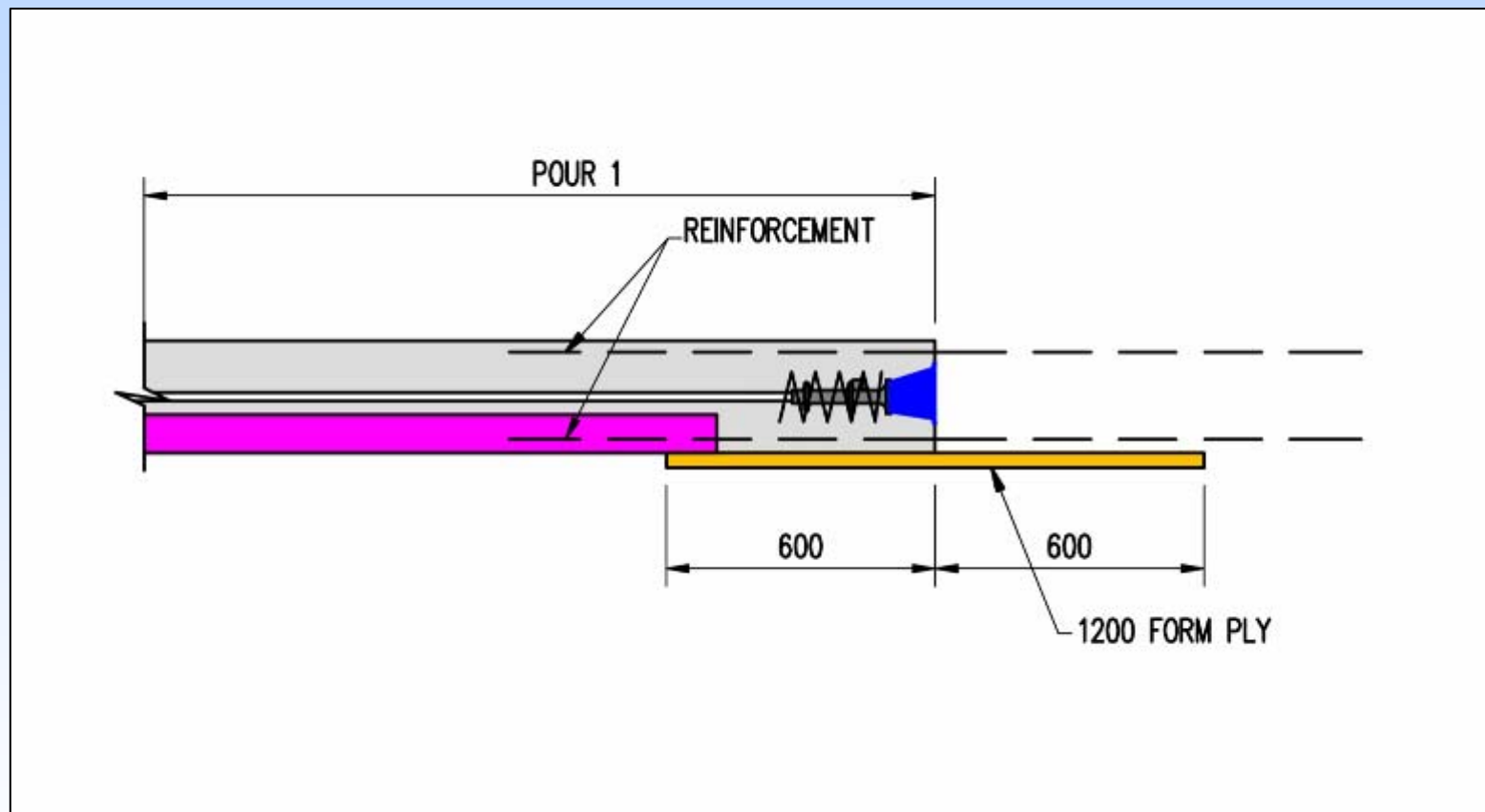


The Use of Metal Deck Formwork



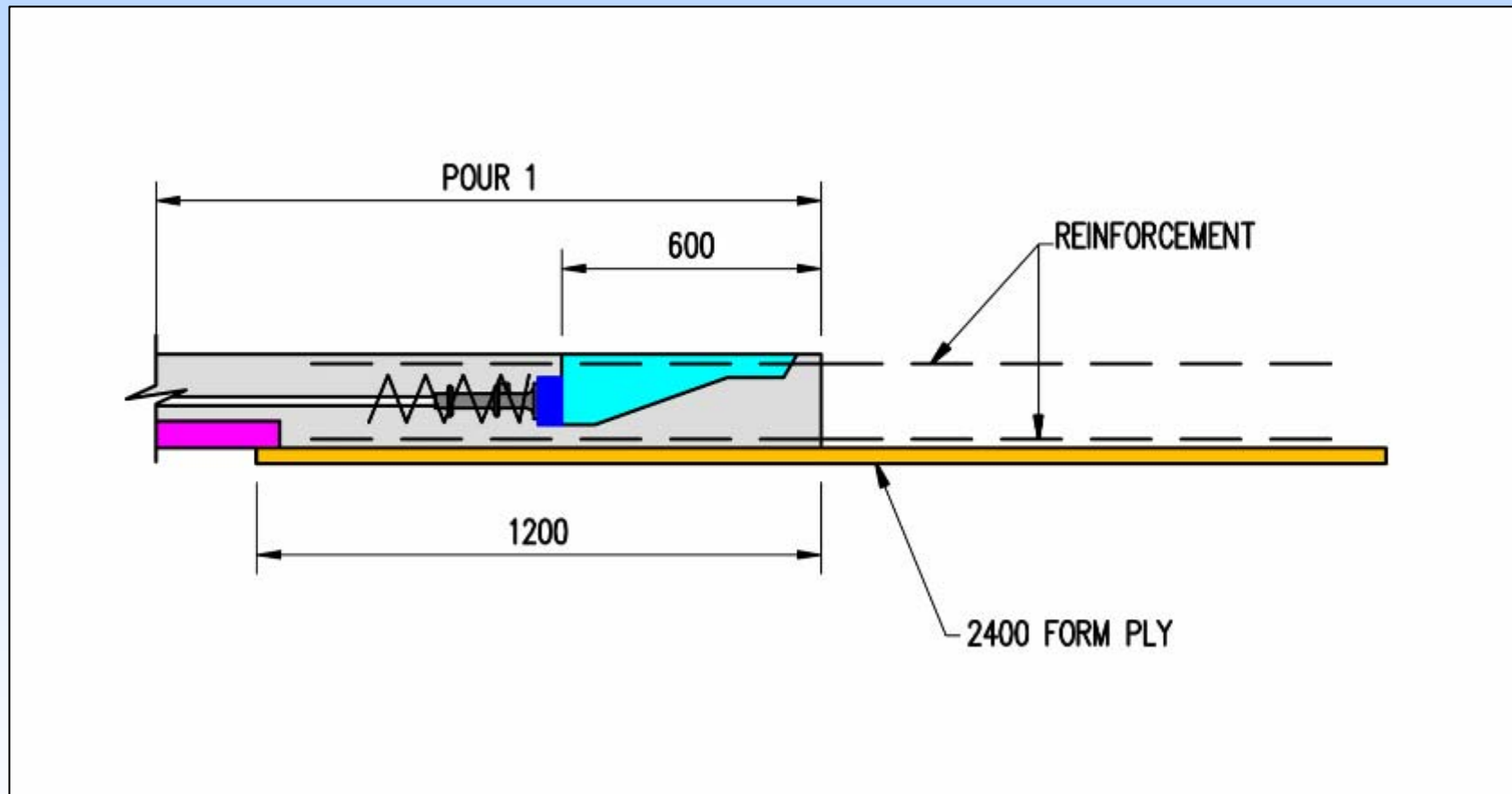
Minimum slab thickness

The Use of Metal Deck Formwork



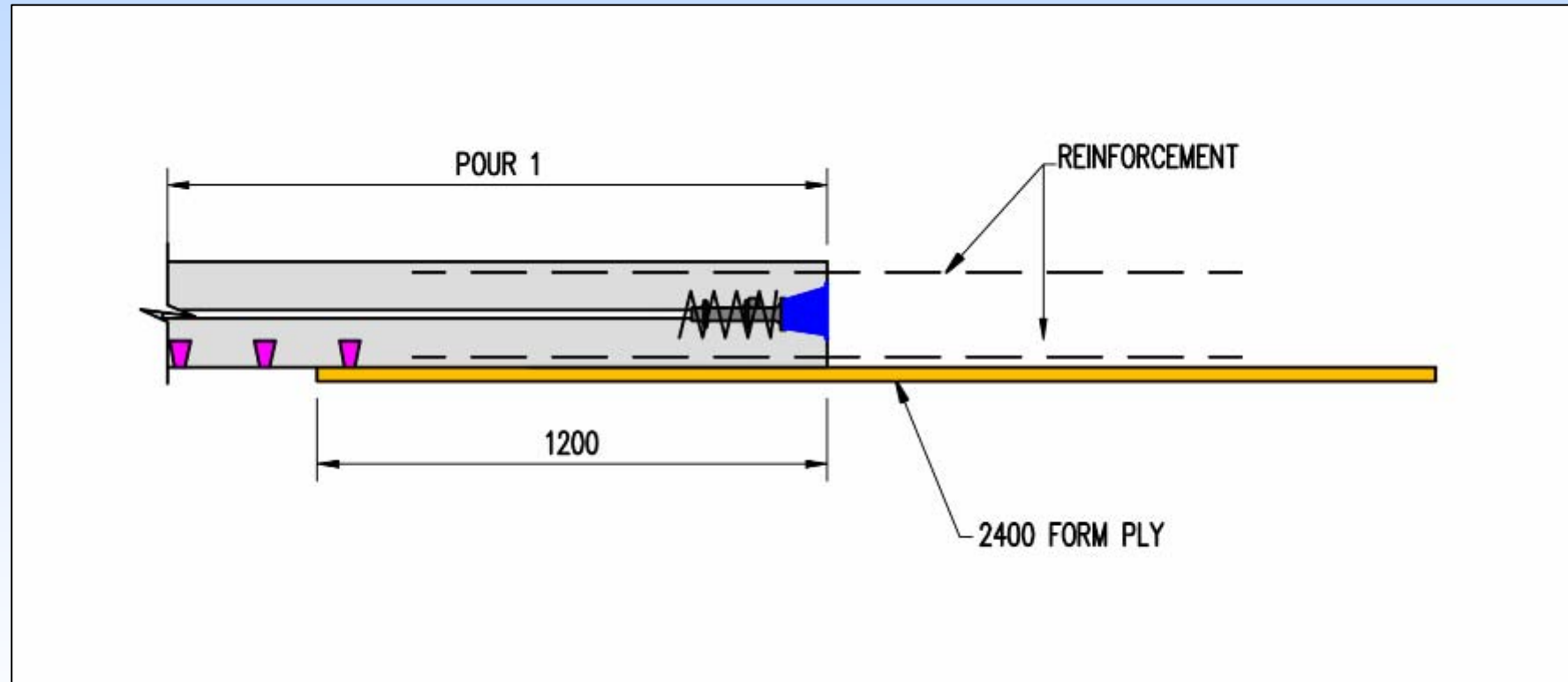
Construction Joint Perpendicular to Ribs

The Use of Metal Deck Formwork



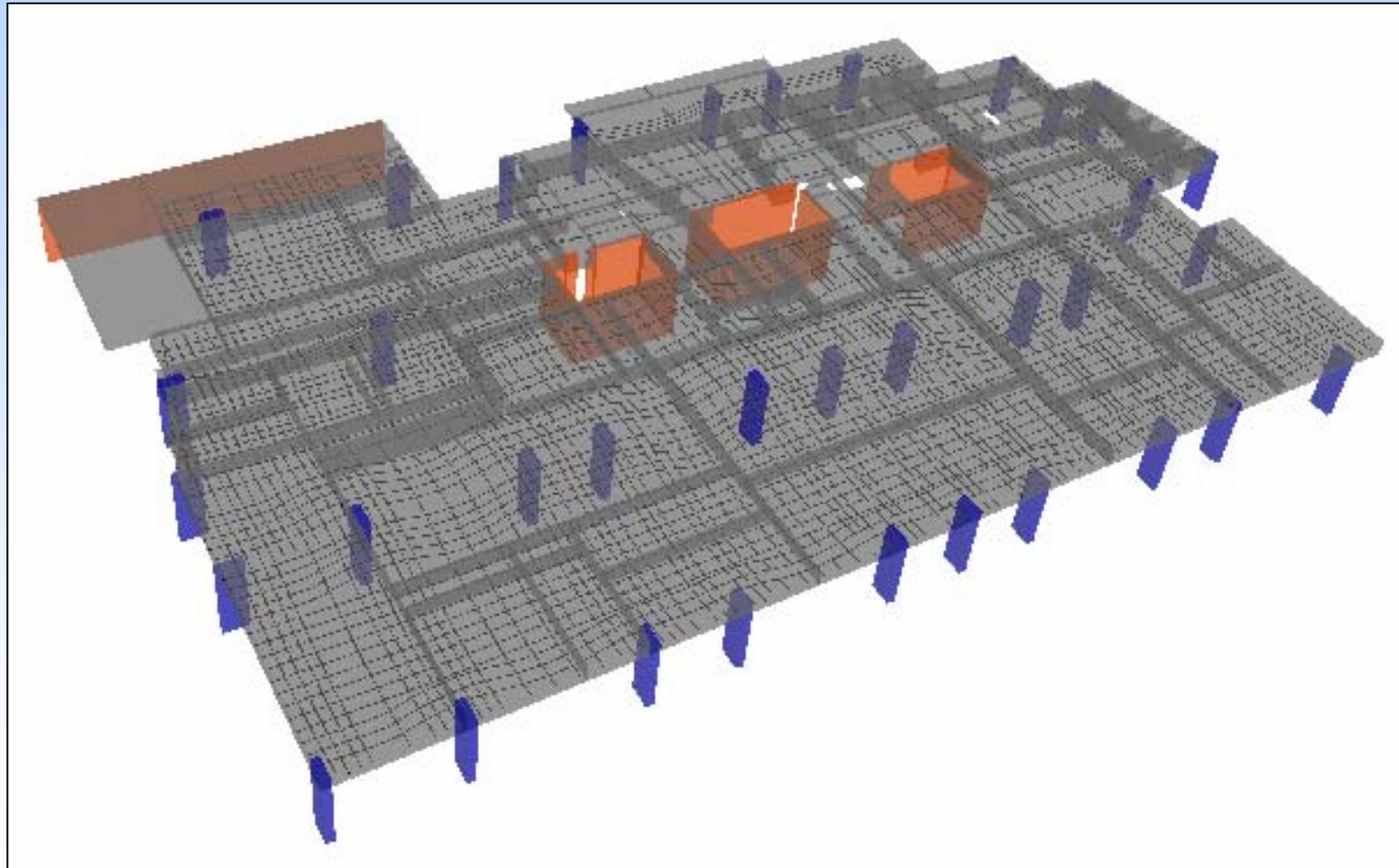
Construction Joint and Stressing Pocket

The Use of Metal Deck Formwork



Construction Joint Parallel to Ribs

Finite Element Methods



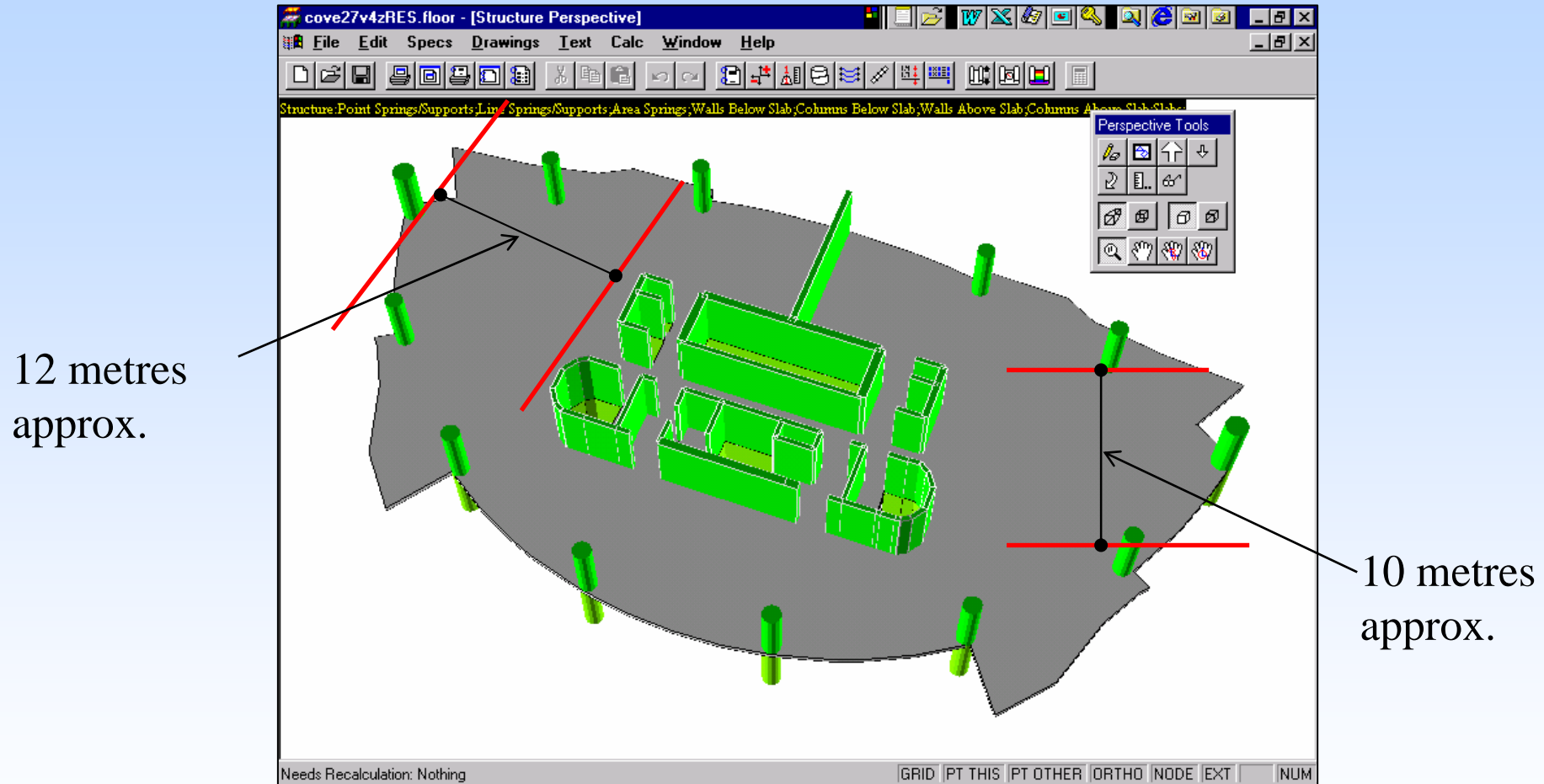
Finite Element Methods

- In use for irregular structures for many years



The Cove Apartments,
The Rocks, Sydney

Finite Element Methods

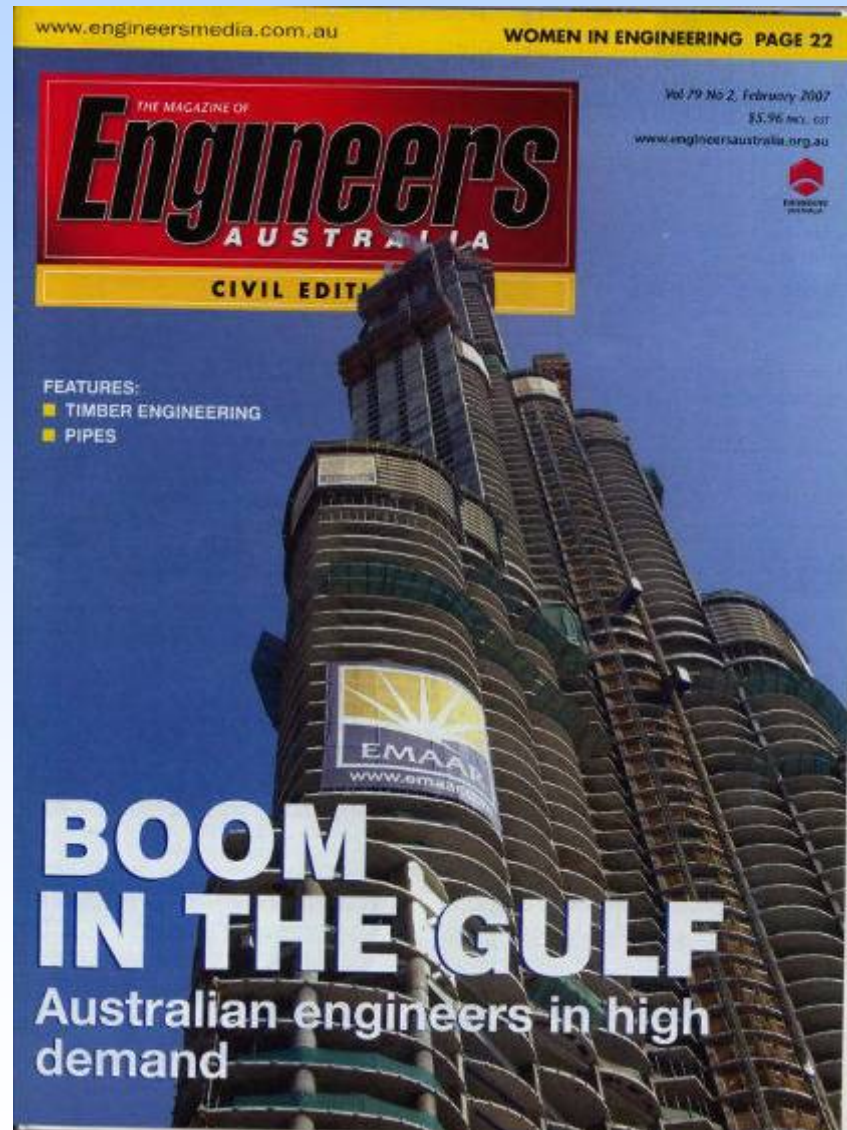


Structure Perspective

Finite Element Methods

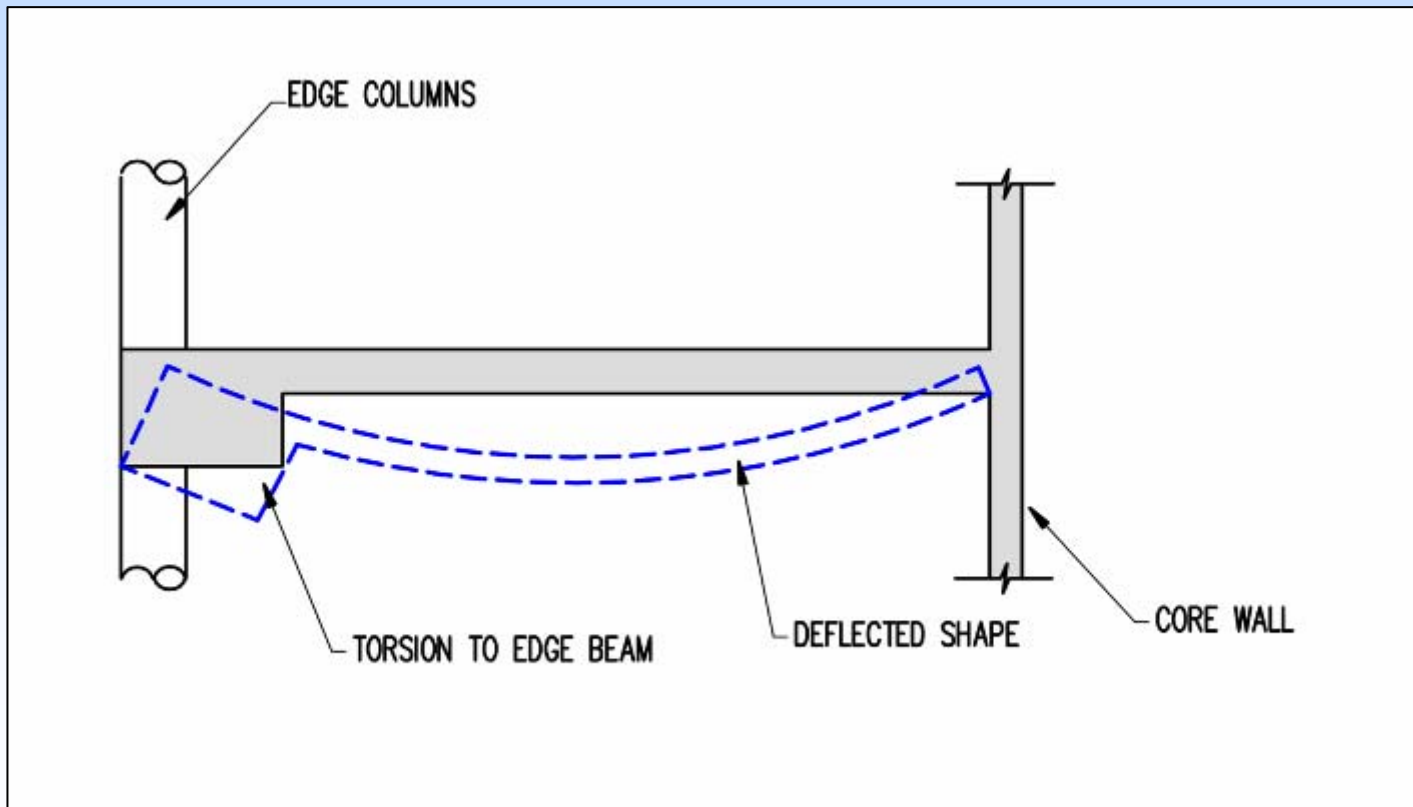
- Advantages
 - Design irregular structures with confidence
 - Floor can be analysed quickly
 - Interface with drafting software

Finite Element Methods



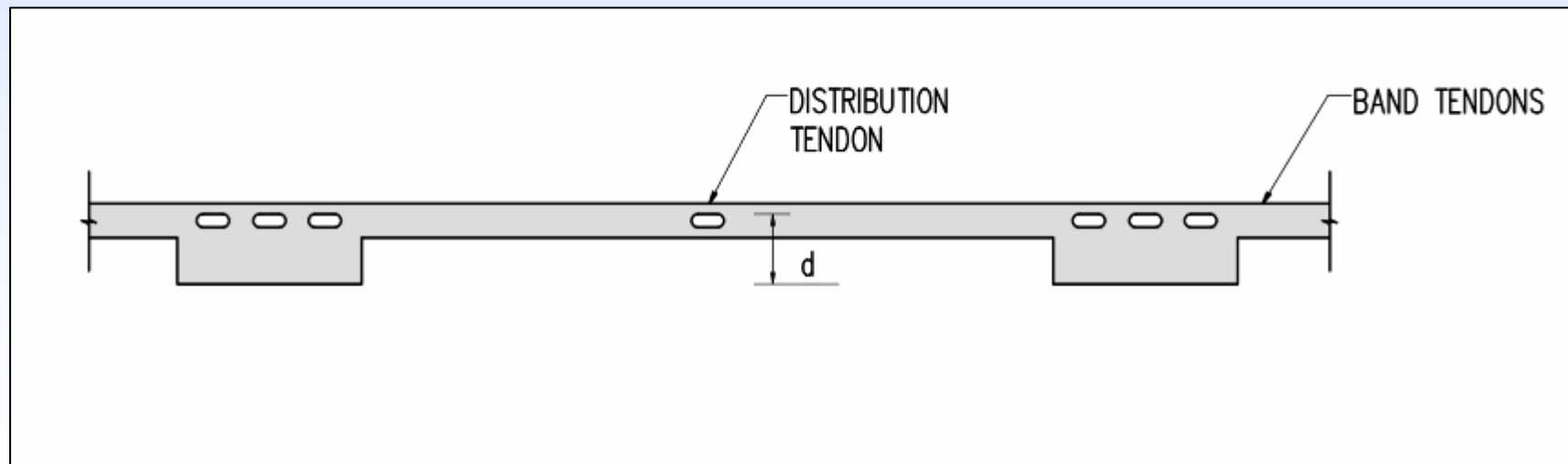
Finite Element Methods

- Torsion to edge of slab



Finite Element Methods

- Ensure all moments are included in the design
 - Mxy moments
- Careful with two way average moments
 - Carefully check strip widths



Finite Element Methods

- Transfer of moments into supporting elements
 - AS3600 – 25% full panel moments resisted at the column (clause 9.1.2)
 - Check the localised area around the column (not just the column strip width)
 - Check that moment transferred into column front face is able to be resisted
 - At least 1 tendon must be located close to the column face

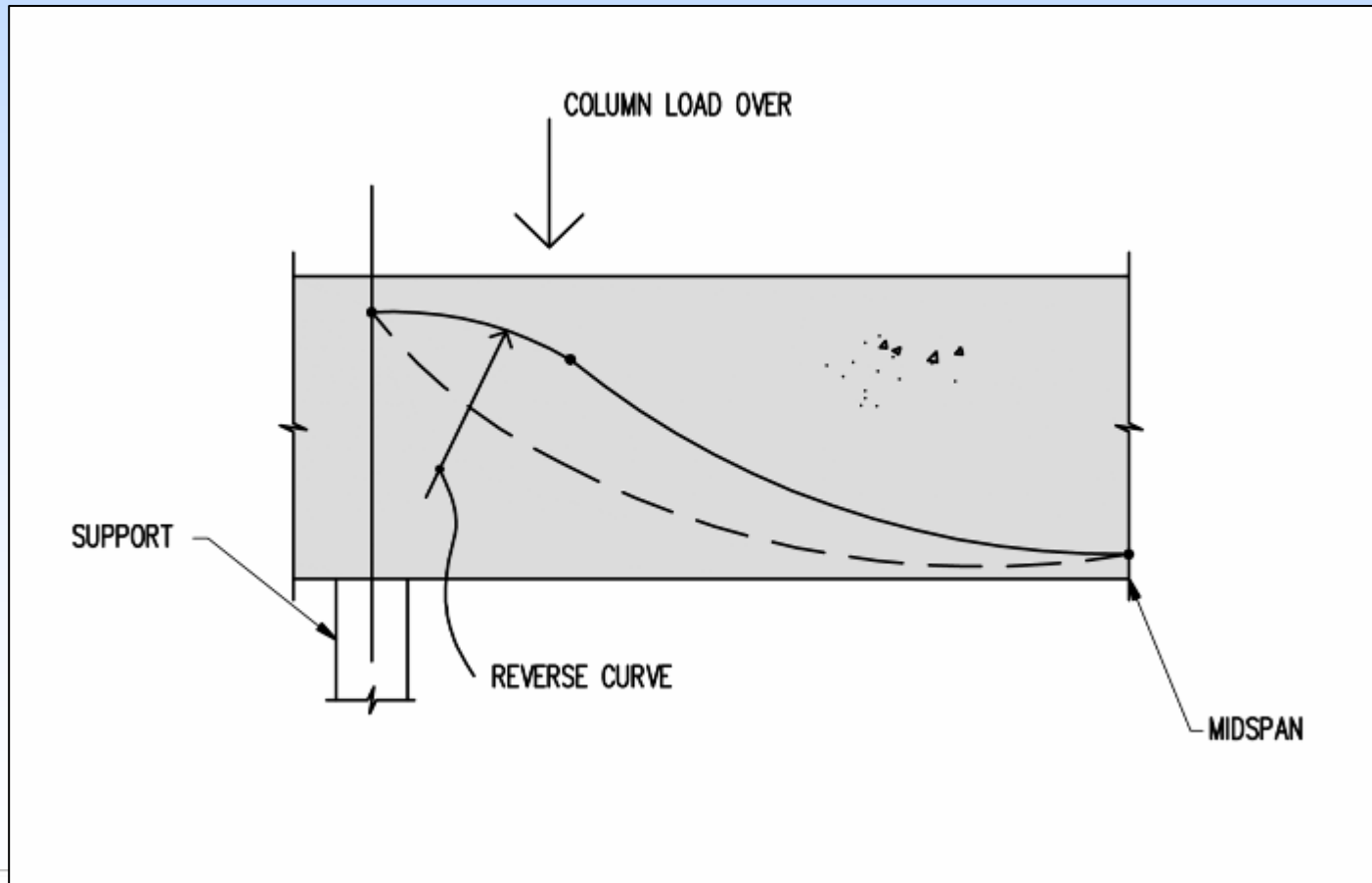
Finite Element Methods

- Deflection

- Calculate $I_{\text{effective}}$ (Branson's formula)
- Service stress limits
- Service stresses above $0.25\sqrt{F'c}$
 - Bonded tendons or reinforcement close to the tensile face
- Long term load cases
 - $(DL + P-T) \cdot (1+k_{cs}) + (\Psi_i \cdot k_{cs}) \cdot LL + \Psi_s \cdot LL$
 - $(DL + P-T) \cdot 3 + LL \cdot 1.5$

Finite Element Methods

- Correct modeling of tendon profiles



Finite Element Methods

- Other factors to consider
 - Verification of the design
 - Calculation of losses
 - Minimum P/A to ensure control of shrinkage cracks
 - Punching shear calculations (to columns over as well)

Conclusion

- Understand how metal deck formwork affects the structure
- Detailing is critical
- Finite Element methods can be advantages
- Understand what the software is doing
- Understand the limitations of the software
- Verify your design!