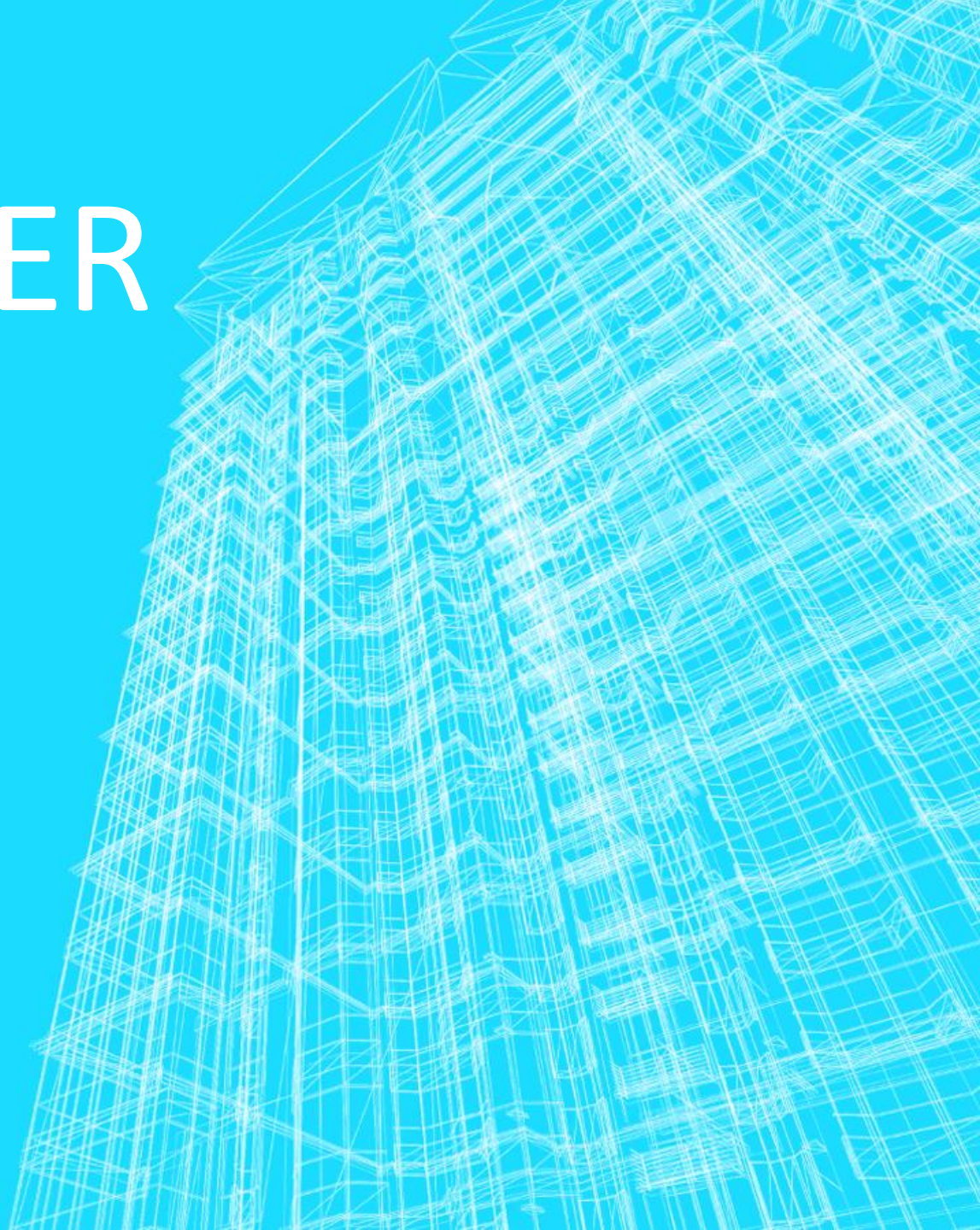
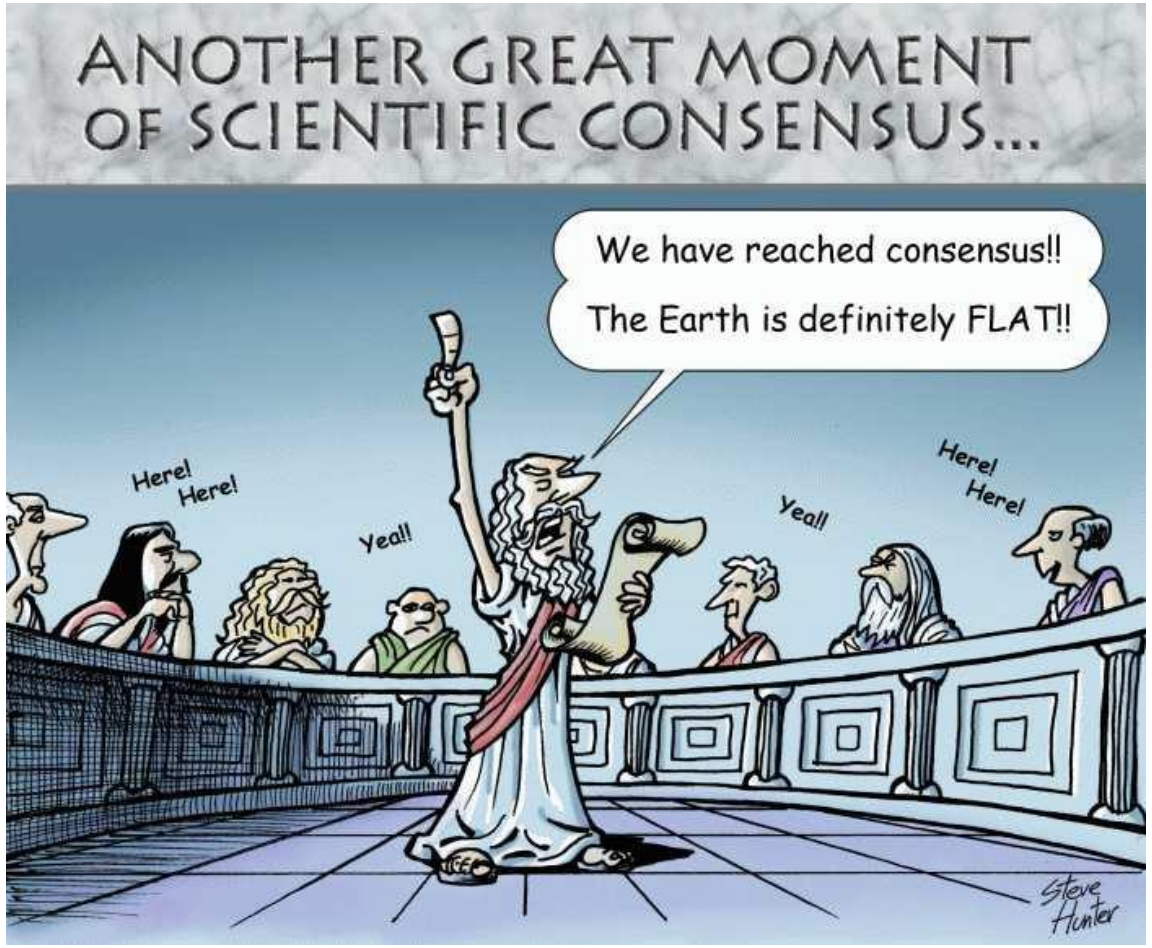
FRP, GEOPOLYMER CONCRETE AND HYBRID STRUCTURES



Presented by Joe Ash
Wagner CFT

IT'S NOT NEW IS IT?



CHANGE IS INEVITABLE

FRP AS AN ALTERNATIVE TO TRADITIONAL MATERIALS

- What is it?
- The Alphabet Soup
- Resins. Do they matter? And the importance of wet out.
- Not all Glass is created equal

DESIGNING IN FRP

- Design, Strength and Deflection

- Design Guides and Australian Standards

MANUFACTURING TECHNIQUE IS A DIFFERENCE MAKER

- How it is made is important.

IF IT LOOKS GOOD, IT IS GOOD

- Asset management.
- Maintenance
- Recycle vs Re-use

COATINGS VS PIGMENT

- Learning lessons and success through testing

SO HOW DOES IT ALL HELP

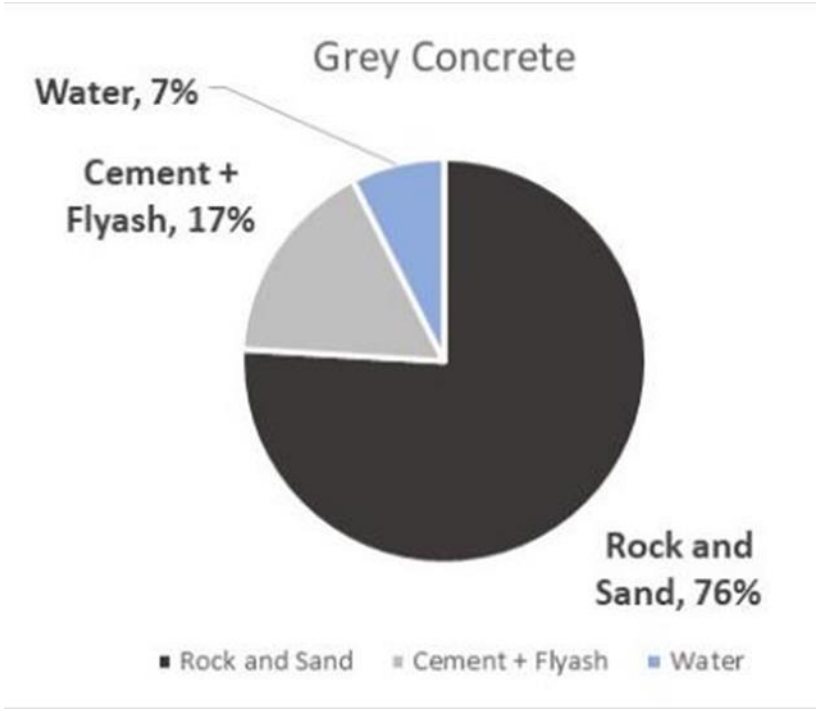
- Speed of install for bridges and pedestrian structures
- Weight
- Maintenance
- Solid QA
- Ecological compliance (acid sulphate soils and Water)
- HR

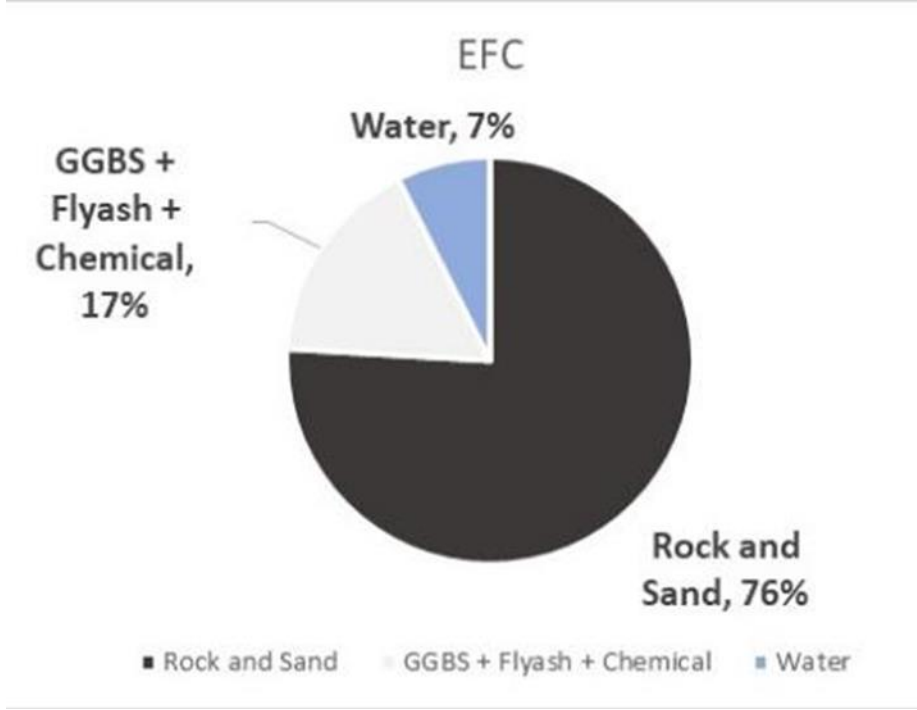
APPLICATION

GEOPOLYMER CONCRETE AS ALTERNATIVE TO TRADITIONAL CONCRETE

- What is it?
- Why should I specify it?
- Is it as strong enough?

COMPOSITION





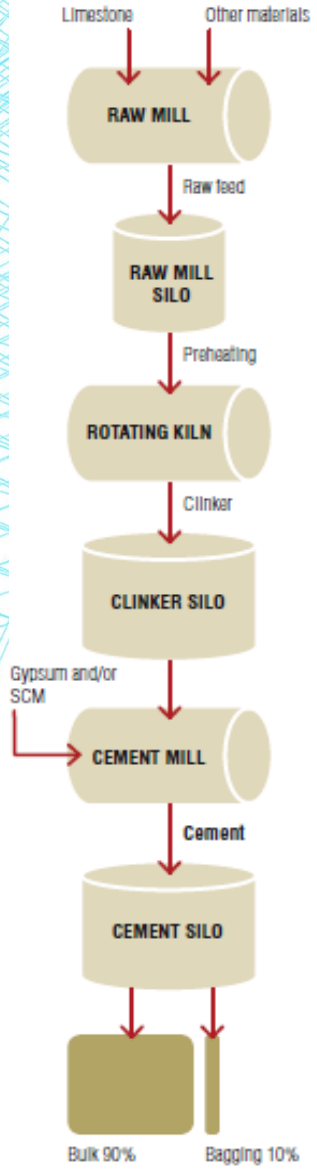


Figure 2 Cement manufacture

THE GREEN DISCUSSION

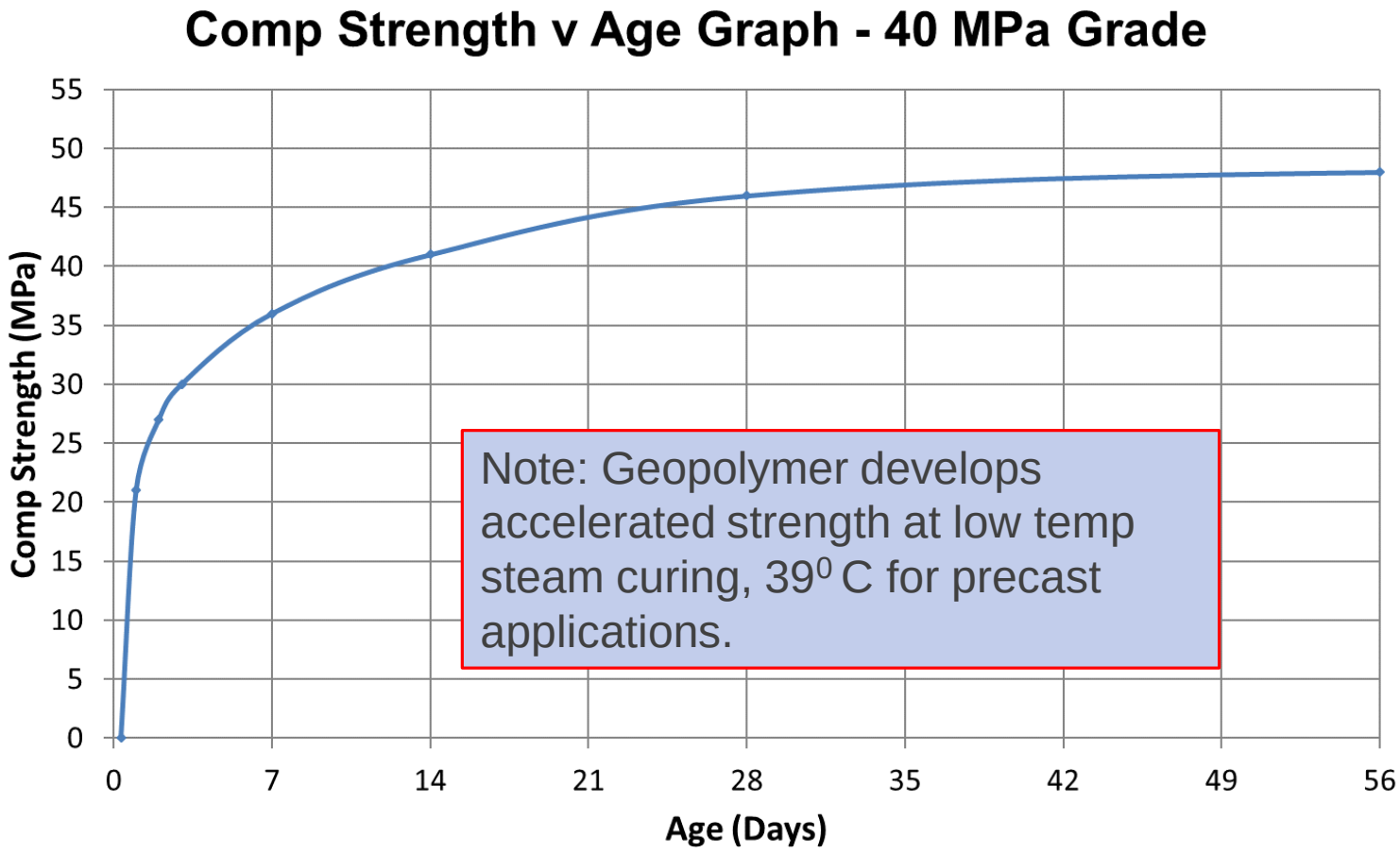
- Extremely low CO_2 emission and embodied energy
- Geopolymer binder has 80 % reduction CO_2 emissions compared to Portland Cement
- Recycled materials: slag and flyash
- CO_2 Emissions Reduction
  - 1 m^3 EFC® 40 MPa saves *220 kg of CO_2*
  - Globally, 1 tonne of Portland Cement produces 1 tonne CO_2
  - 8% of the world's total CO_2 emissions.

THE WHY

- ***BENEFITS OF Geopolymer Concrete compared to conventional concrete***
- **30% higher flexural tensile.**
- **Far lower drying shrinkage than conventional concrete when tested to AS 1012.13.**
- **Vastly improved durability performance. Validated through independent testing and R&D studies by RMIT University in Melbourne (2012) and IBAC Institute, Aachen University, Germany under direction of BU Consultants Dr Stephan Uebachs (2018). o higher resistance to chloride ion induced corrosion of embedded reinforcing steel**
- **higher sulphate attack resistance**
- **higher acid attack resistance**
- **very low heat of reaction which eliminates the risk of thermal micro cracking**
- ***Geopolymer Concrete* is the lowest carbon emission concrete available in the world today.**
- ***Geopolymer Concrete* has a higher level of fire resistance than conventional concrete as evidenced by fire testing conducted at CSIRO.**

Mechanical Material Property	EFC (compared to Portland Cement Concrete)
Compressive strength	equivalent
Flexural tensile strength	30% higher
Early age strength	good
Drying shrinkage	Lower (average 350 με @ 56 days)
Youngs Modulus (stiffness)	Similar ; 10% higher
Poissons Ratio	Similar ; 0.20 – 0.24

HARDENING UP



	GP cement	GP ; Flyash (FA) ; Silica Fume (SF)	GP ; FA ; SF + Biocide	Calcium Aluminate cement	Geopolymer
Binder solids (kg)	450	450	454	450	450
w/b ratio	0.36	0.36	0.35	0.42	0.43
Slump (mm)	230	220	220	220	140
28d Comp (MPa)	87.5	78.0	77.5	74.5	53.0
Chloride ion migration coefficient ($10^{-12}m^2/s$)	5.4	1.7	1.5	0.70	0.84
Chloride ion diffusion coefficient ($10^{-12}m^2/s$)	4.6	1.4	1.2	1.6	0.48

COMPOSITE REBAR

- Corrosion Resistance - will not rust, and are impervious to the action of salt ions, chemicals, and the alkalinity inherent in concrete.
- Superior Tensile Strength - composite rebar offers a tensile strength up to twice that of steel.
- Thermal Expansion - Basalt rebar offers a level of thermal expansion comparable to concrete.
- Electrical and Magnetic Neutrality - contains no metal, and will not interfere with the operation of sensitive electronic devices such as medical MRI units or electronic testing devices.
- Thermal insulation - highly efficient in resisting heat transfer, such as from building exteriors to interiors.
- Lightweight - weighs approximately one-quarter the weight of an equivalent size steel bar, offering significant savings in

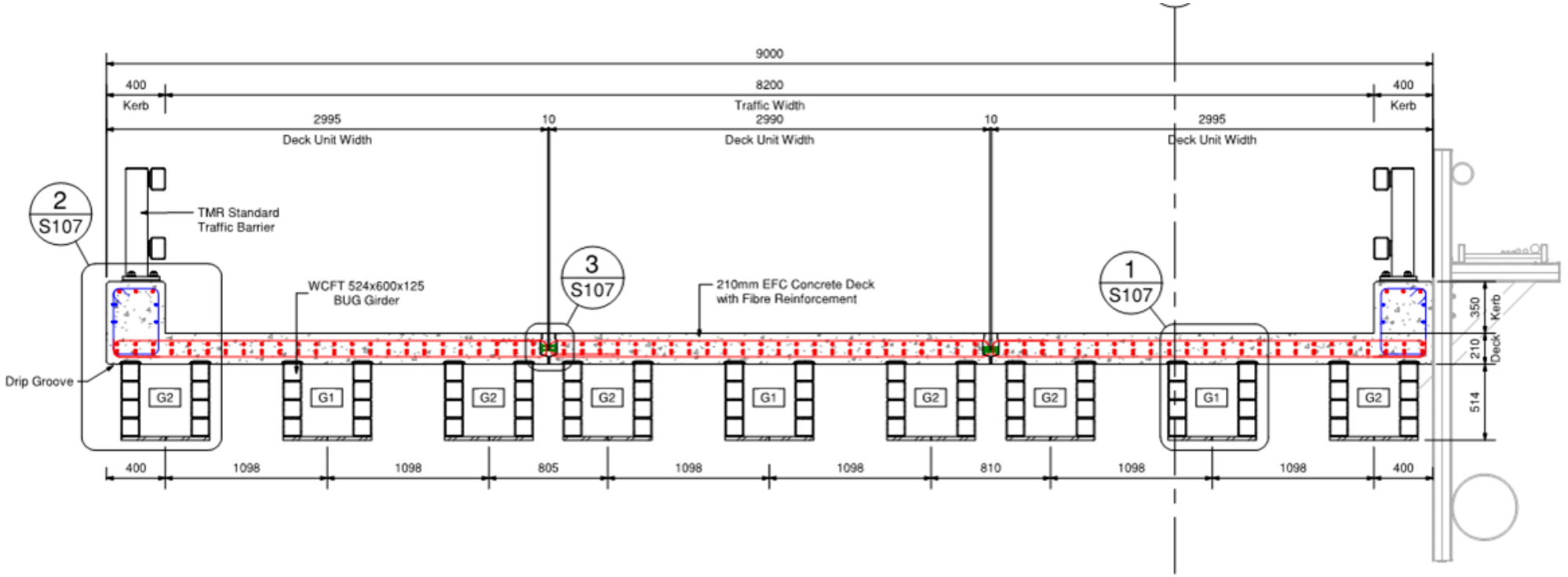
HOW IT ALL COMES TOGETHER

FRP REBAR AND PRECAST

HYBRID STRUCTURES – THE WHARF

- Steel piles and headstock beams
- ‘Hybrid prefabricated deck panels’
  - CFT U-Girders + EFC deck with FRP reinforcement
  - 192 no. units manufactured at Wagners Precast
- Deck unit design undertaken by i-cubed engineers
  - 6 MPa flex strength
  - 50 MPa compressive strength
- Manufacture requirements
  - 20 MPa strip strength in 14 hrs

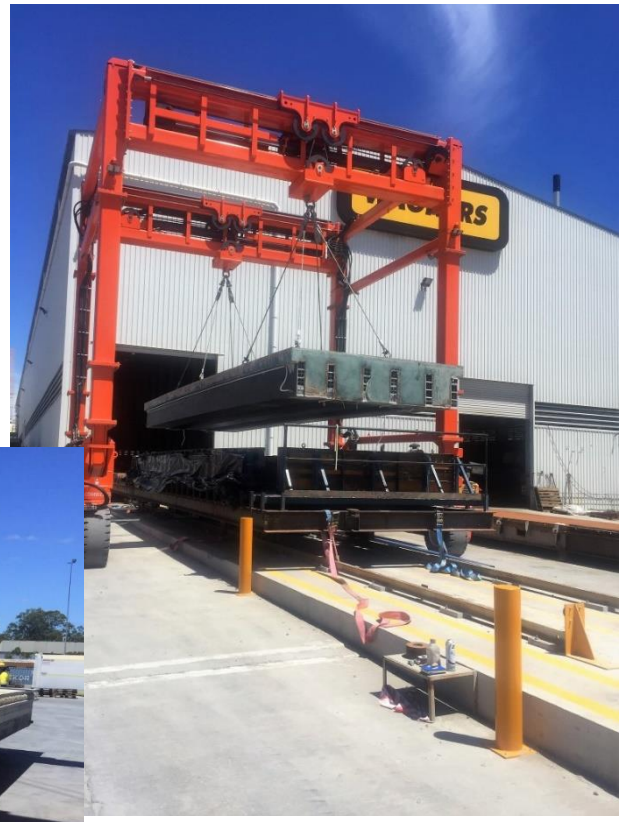
DESIGN


9000
400
Kerb
8200
Traffic Width
400
Kerb
2995
Deck Unit Width
10
2990
Deck Unit Width
10
2995
Deck Unit Width
2
S107
TMR Standard
Traffic Barrier
WCFT 524x600x125
BUG Girder
3
S107
210mm EFC Concrete Deck
with Fibre Reinforcement
1
S107
Drip Groove
G2
G1
G2
G2
G1
G2
G2
G1
G2
350
Kerb
210
Deck
514
400
1098
1098
805
1098
1098
810
1098
1098
400

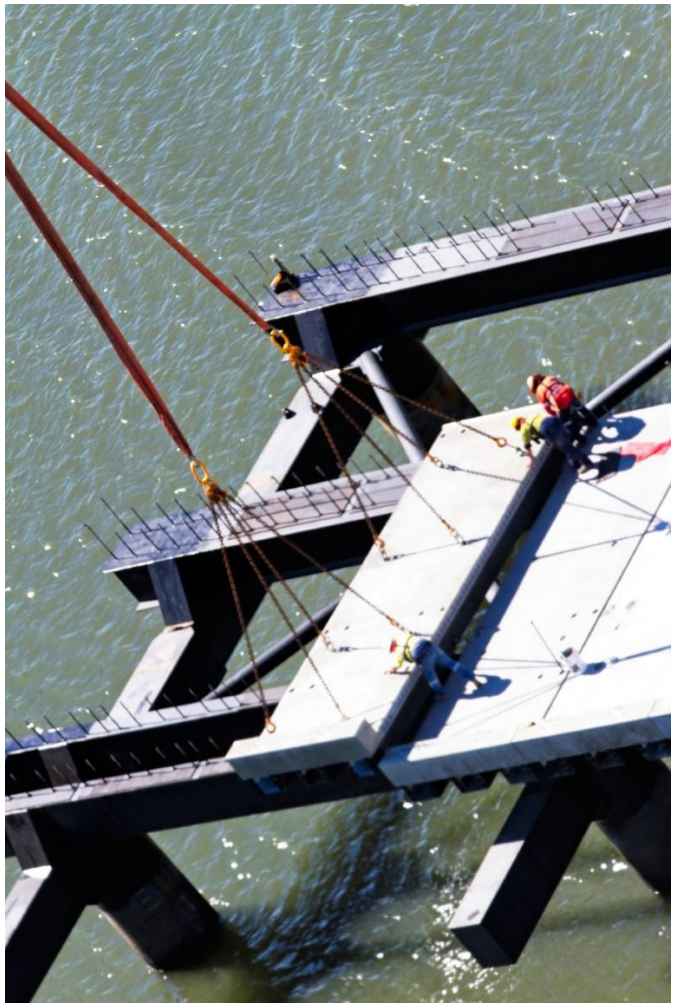
CONSIDERATION

- Cranage, diminishing gains
- Lifespan
- Speed
- Reduced support structure
- Environmental considerations

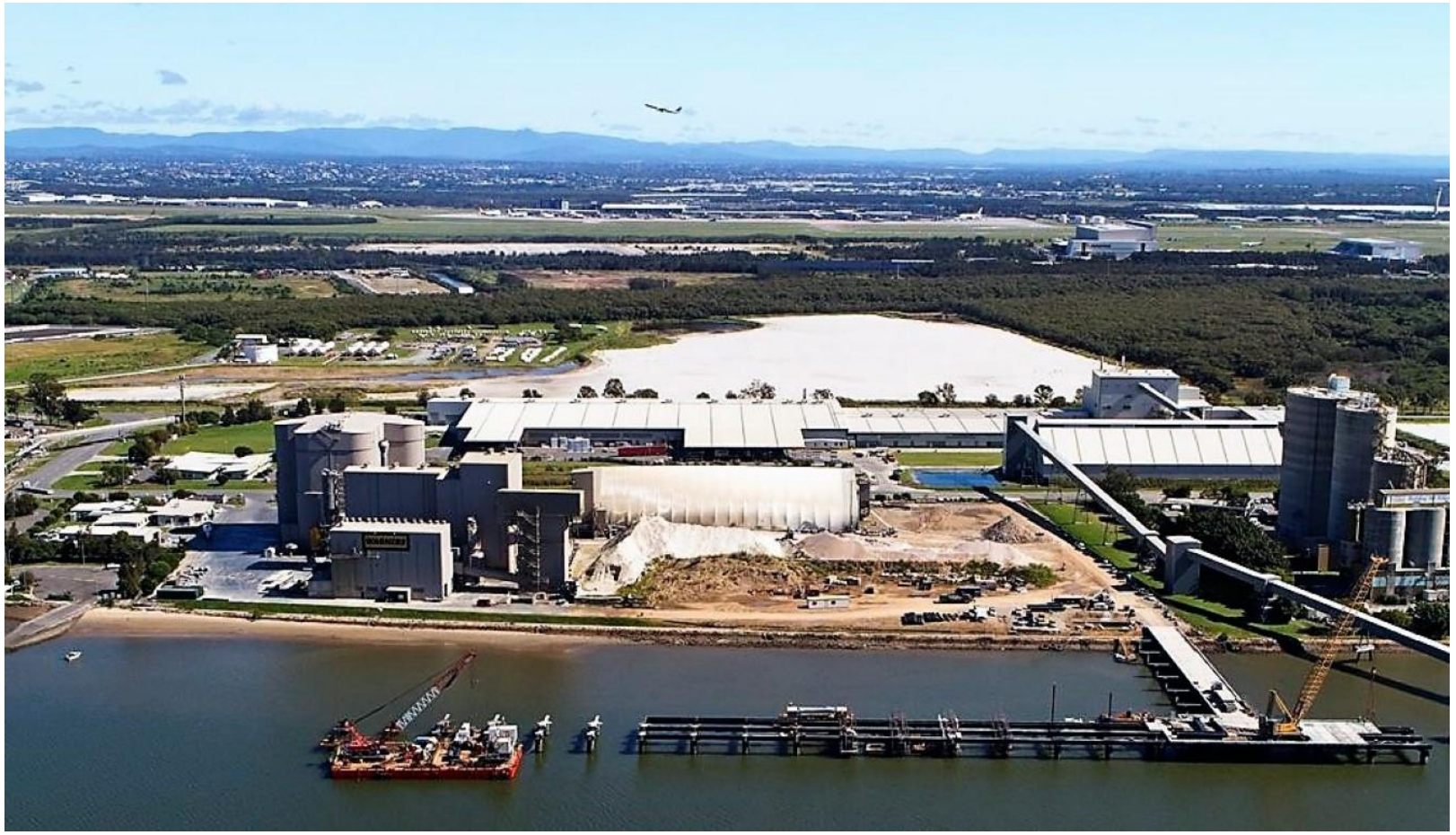
HYBRID PANEL PRODUCTION



INSTALLATION



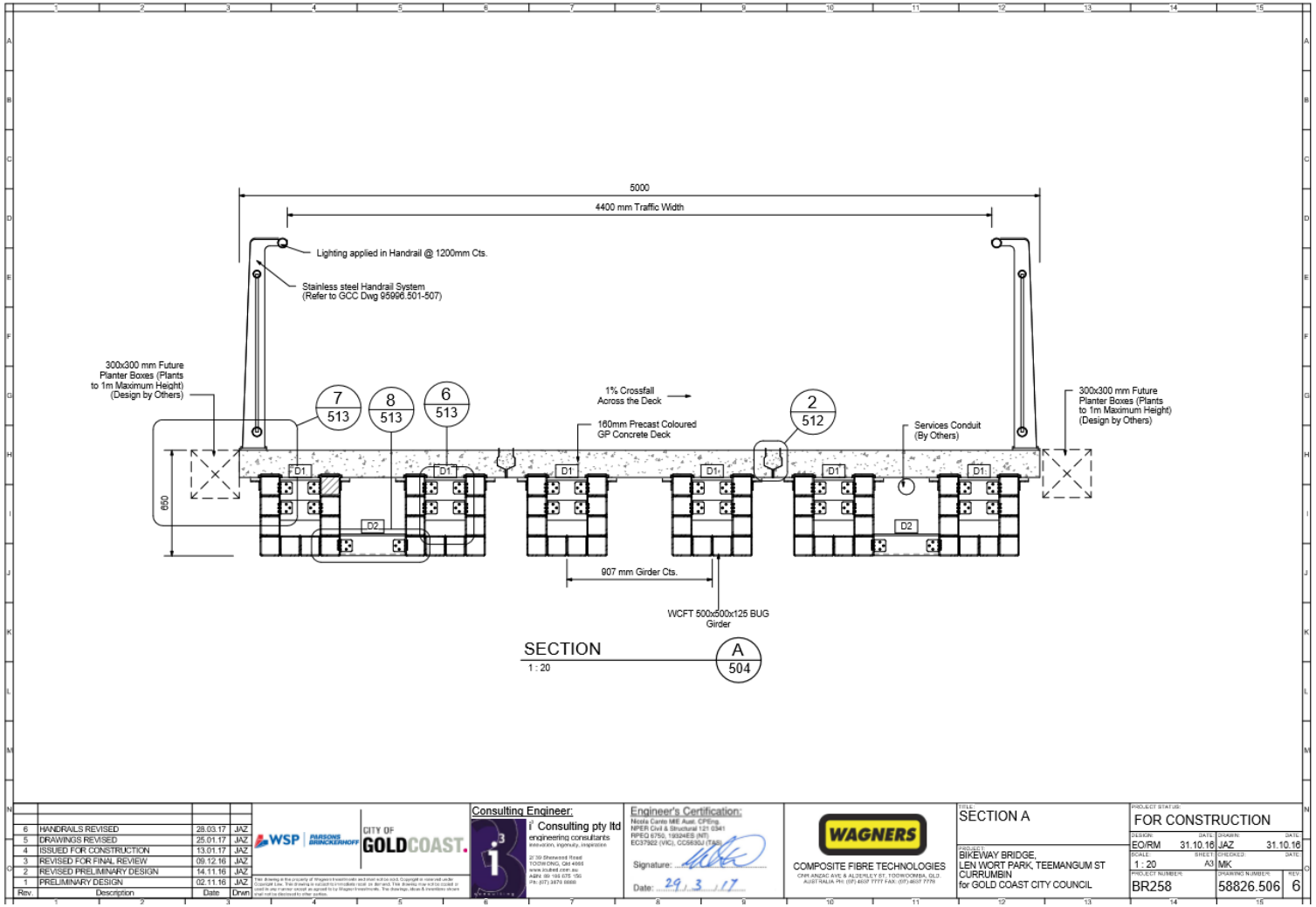
HOME STRETCH



CURRUMBIN PEDESTRIAN BRIDGE

- Design requirements
- Sympathetic to existing infrastructure
- Concrete selection
- Speed of install
- Reduction of equipment

DESIGN


5000
4400 mm Traffic Width
Lighting applied in Handrail @ 1200mm Cts.
Stainless steel Handrail System
(Refer to GCC Dwg 95996.501-507)
300x300 mm Future
Planter Boxes (Plants
to 1m Maximum Height)
(Design by Others)
7
513
8
513
6
513
1% Crossfall
Across the Deck
160mm Precast Coloured
GP Concrete Deck
2
512
Services Conduit
(By Others)
300x300 mm Future
Planter Boxes (Plants
to 1m Maximum Height)
(Design by Others)
650
D1
D2
907 mm Girder Cts.
WCFT 500x600x125 BUG
Girder
SECTION
1 : 20
A
504
Rev. Description Date Drwn
6 HANDRAILS REVISED 28.03.17 JAZ
5 DRAWINGS REVISED 25.01.17 JAZ
4 ISSUED FOR CONSTRUCTION 13.01.17 JAZ
3 REVISED FOR FINAL REVIEW 09.12.16 JAZ
2 REVISED PRELIMINARY DESIGN 14.11.16 JAZ
1 PRELIMINARY DESIGN 02.11.16 JAZ
WSP PARSONS BRINCKERHOFF
CITY OF GOLDCOAST.
Consulting Engineer:
i3 Consulting pty ltd
engineering consultants
Engineer's Certification:
Signature:
Date: 29/3/17
WAGNERS
COMPOSITE FIBRE TECHNOLOGIES
SECTION A
BIKEWAY BRIDGE,
LEN WORT PARK, TEEMANGUM ST
CURRUMBIN
for GOLD COAST CITY COUNCIL
PROJECT STATUS:
FOR CONSTRUCTION
DESIGN: EO/RM 31.10.16
DRAWN: JAZ 31.10.16
SCALE: 1 : 20
SIZE: A3
CHECKED: MK
PROJECT NUMBER: BR258
DRAWING NUMBER: 58826.506
REV: 6

FRP ELEMENTS

INSTALLATION

COMPLETED PROJECT

SM 1600 ROAD BRIDGES (SHORT SPAN)

NEW APPLICATIONS

NEW APPLICATIONS

OTHER THINGS

- Light poles
- Electrical Crossarms
- Wave Attenuators
- Maritime structures
- Aviation Infrastructure
- Civil infrastructure

Thank You For Your Time.

Questions?